of species by Moghe (1933) in the size of the rostellar hooks, in having hooks of one size only and in the number of testes, and we propose for it the name, *Ophryocotyloides monocantis* with the following specific diagnosis :—Length 40 mm., maximum width 2·42 mm.; restellum armed with two rows of equal hooks, each 8μ in length; suckers armed with three rows of minute hooks; testes 30 to 35 in number, each 60μ in diameter; eggs in balsam 27μ×21μ.

Host.—Tree Pie, *Dendrocitta rufa* (Scop.).

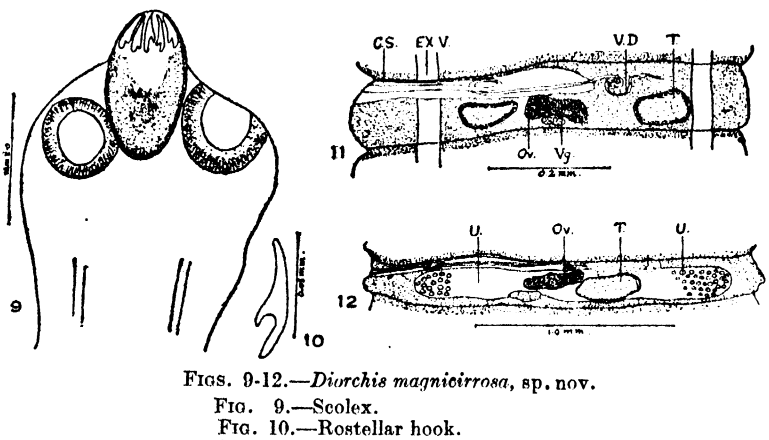
Habitat.—Intestine.

Locality.—United Provinces, India.

Diorchis magnicirrosa, sp. nov.

Three mounted slides of entire worms were given to one of us (M. A. M.) by Mr. S. C. Verma of Zoology Department, University of Allahabad. The host was described as a 'Dove' and it is not clear which particular species of the family Columbidae it represents. We are indebted to Mr. Verma for giving us this material.

Anatomy.—Total length of worm 225 mm. with a maximum width of 0·65 mm. Proglottids 0·1 to 0·15 mm. in length and 0·525 to 0·625 in width in the different regions of the strobilus. All segments wider than long. Genital pores unilateral, genital ducts passing dorsally to the longitudinal excretory vessels. Scolex (fig. 9) 0·44 mm. in length and 0·4 mm. in maximum width. Rostellum 0·224 mm.×0·165 mm. with a single row of 10 hooks; each hook is 60μ in length and has the shape shown in fig. 10. Suckers 0·16 mm.×0·128 mm., unarmed. Scolex followed by a short unsegmented region. Two testes (fig. 11, *T*)



FIGS. 9-12.—*Diorchis magnicirrosa*, sp. nov.
FIG. 9.—Scolex.
FIG. 10.—Rostellar hook.
FIG. 11.—Entire mature proglottid.
FIG. 12.—Entire gravid proglottid.

in each proglottid, one on either side of the ovary which is centrally placed; aporal testis larger of the two. Cirrus sac (*C. S.*) reaches beyond the centre of the proglottid; cirrus straight near the lateral margin, but bent on itself in the middle of the cirrus sac, inner end of cirrus sac dilated to form a vesicula seminalis. Ovary (*Ov.*) situated in the centre of proglottid between the two testes; very small in size in early mature proglottids, but in fully mature ones of the same size as

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PART II.—*Published June, 1934.*

PART III.—*Published October, 1934.*

LIST OF PLATES.

[1] Explanations of figures 7*a* and 7*b* of plate IX were unfortunately omitted. These should read as :—

7*a*. *Pseudodendrothrips ornatissimus* Schn. Anterior region.
7*b*. *Pseudodendrothrips ornatissimus* Schn. Antenna, segments 6-8.

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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or sub-species; a dagger (†) indicates a new species; a double dagger (‡) a new genus or sub-genus; a double asterisk (**) a new family or sub-family; synonyms are printed in italics.]

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NOTES ON THE BIONOMICS OF *TROCHUS NILOTICUS* LINN.

II. ON TWO NEW LIMPET-LIKE GASTROPODS FROM THE ANDAMAN WATERS.

By BAINI PRASHAD, *D.Sc., F.R.S.E., F.A.S.B.*, AND H. SRINIVASA RAO, *M.A., D.Sc., Zoological Survey of India, Indian Museum, Calcutta.*

(PLATE I.)

In a recent paper of this series a new species of Vermetid living on the shell of *Trochus niloticus* and causing damage to the periostracal layer was described[1]. In this paper the description of two other Gastropod molluscs found on the shells of *T. niloticus* on which they had made moderately deep excavations is given. The animals were found living, and could be removed only with considerable difficulty by means of a sharp knife. Examination of the soft parts and the radula has shown that one of the Gastropods is a true Patellid of the sub-genus *Patellidea* Thiele, and the other is an undescribed genus of the family Lepetellidae described here under the name *Saptadanta*,[2] gen. nov.

Family PATELLIDAE.

Subgenus **Patellidea** Thiele.

1891. *Patellidea*, Thiele in *Troschel's Gebiss der Schnecken*, II, p. 315.
1929. *Patellidea*, Thiele, *Handbuch Syst. Weichtierkunde*, p. 40.

Thiele proposed this genus in 1891 for forms of the type of *Patella granularis* Linn. on the basis of differences in the radular teeth. In his later work in 1929, however, he considered *Patellidea* to be a group of the subgenus *Scutellastra* H. and A. Adams. In view of characteristic difference in the form and disposition of the central tooth we are of the opinion that *Patellidea* should be treated as a separate subgenus equal in rank to *Scutellastra*.

According to Pilsbry[3] the shell of the group of *P. granularis* Linn. is " oval, sculptured with numerous granulose riblets, none of them notably larger. Central tract of the inside and border generally dark ", while Thiele only remarks under the subgenus *Scutellastra* that the inner surface of the shell is porcellanous and not iridescent.

Patella (Patellidea)[4] tara, sp. nov.

The shell is of small size, ovoid in outline, star-shaped, solid, slightly conical with the apex subcentral. It is 14 mm. long. 12 mm. broad, and 3·5 mm. high. The sculpture consists of 9 main groups of somewhat raised, radial ridges, each with 5-6 radial subgranulose riblets, and 3-5

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[1] *Rec. Ind. Mus.* XXXV, p.   pl.X (1933).
[2] From the Sanskrit words *Sapta* seven, and *Danta* teeth.
[3] *Man. Conch.* XII, p. 102 (1891).
[4] From the Sanskrit word *Tara* meaning a star.

low ridges in the interspace between two main ridges, which give the shell a star-like appearance. The colour is a dull greyish brown on the outside, and white porcellanous with a large orange-yellow central tract on the inside, with 2 or 3 rows of elongated black spots along the periphery of this tract.

The radula is a narrow ribbon with 13 teeth in each row with the formula 3·3·1·3·3. The disposition and form of the teeth in one half of each row are shown in pl. I, fig. 2, and it is only necessary to direct attention to the following peculiarities of the dentition: (1) the central tooth is very narrow and inconspicuous being wedged in between the inner laterals; its cutting margin is at a distinctly lower level than that of the inner lateral, (2) the inner laterals have simple, sickle-shaped hooks on their cutting margin, (3) the single outer lateral has a broad cutting margin with 4 denticles and lies at a much lower level than the inner laterals, (4) the outermost of the three marginals is broad and short while the innermost is broader in the middle with its outer margin reflexed in the form of an elongated cusp in addition to the usual cusp of the cutting margin.

Holotype M. $\frac{14308}{2}$ on *Trochus niloticus* from S. Corbyn's Cove, Port Blair, Andamans, in the collection of the Zoological Survey of India, Indian Museum, Calcutta.

Remarks.—Although described from a single specimen we have no hesitation in giving it a new name, as our careful comparison with the descriptions and figures of known species belonging to the *P. granularis* or any other allied group shows it to be quite distinct, both in anatomical and shell characters, from any of the previously described species.

Family LEPETELLIDAE.

The characters of the four genera included in the family are dealt with in detail by Thiele in his monograph in the *Conch. Cab.*[5], and in his recent *Handbuch.*[6] Opinion is divided as to whether the genus *Lepetella* Verrill should be included in this family, on account of the character of the radula, but we have no doubt that the form from the Andamans which we described below under a new generic name is very closely allied to *Lepetella* in the form of the radula.

Genus **Saptadanta**, gen. nov.

The form from the Andamans has quite a different type of shell from that of any of the previously described genera, and although it resembles *Lepetella* Verrill in the number of teeth in each row of the radula, there are several distinctive features in the form and disposition of the individual teeth. The central tooth is not merely a broad quadrate plate with traces of two denticles near the outer margin as in *Lepetella*, but has a distinct broad cutting margin with five well-developed and two rudimentary denticles.

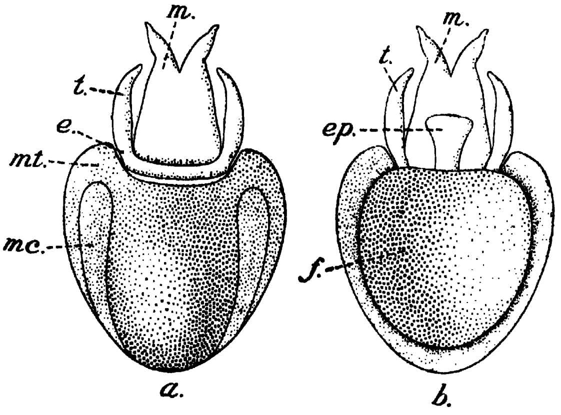
[5] Thiele, J.—Martini-Chemnitz's *Conch.-Cab.* II (Heft XXXIII), *Cocculinoidea*, p. 21 (1909).

[6] Thiele, J.—*Handbuch Syst. Weichtierkunde*, p. 93 (1929).

Saptadanta nasika[1], gen. *et* sp. nov.

The shell is moderately thick, irregularly, oblong or oval, conical with the more or less well-marked recurved obtuse apex placed in the posterior third of the length of the shell, and has 19 distinct convex, radiating ridges some of which are forked near the outer margin of the shell. The ground colour of the shell is white to dirty yellowish brown. The interspaces between the ridges at the anterior end are brownish in colour. The peripheral margin of the shell is comparatively thin and is separated from the rest of the shell by a shallow groove, and when viewed from the sides exhibits distinct lines of growth at the thickened outer ends of the radiating ridges. The inner surface of the shell is smooth, porcellanous, with the central tract distinctly whiter than the rest of the area. The inter-spatial brown markings between the ridges on the outer surface are seen as radiating bands which end peripherally in yellowish spots. Owing to the worn condition of the outer surface of the shell, which also bears traces of minute excavations by boring organisms, the sculpture is not evident, but on the smooth inner surface the minute irregularly concentric impressed lines and the radiating lines outside the central tract are very clearly seen under a fairly high magnifying lens. The dimensions of the shell are 8 mm. long, 6·7 mm. broad, and 3 mm. high.

The muzzle is more or less triangular in form, stout, compressed from above downwards, forked at the distal extremity, each prong of the fork being leaf-shaped with its tip acuminate. The tentacles arise from the outer side of the muzzle, and are elongate, broad at the base and tapering



TEXT-FIG. 1.—*Saptadanta nasika*, gen. et. sp. nov. *a* and *b* dorsal and ventral views of the animal (× *ca* 10); *e.* eye; *ep.* epipodium; *f.* foot; *m.* muzzle; *mc.* muscle; *mt.* mantle.

[1] The specific name in Sanskrit meaning nose has reference to the nose-shaped projecting apex of the shell.

gradually towards the extremity. A dark circular spot at the outer base of each tentacle represents the eye. On the underside of the muzzle, between it and the foot lies a fan-shaped lamellar structure which probably represents an epipodium.

The radular formula is 2·1·1·1·2. The central is much broader than high; it bears a strongly reflected cutting edge with seven cusps, and is produced into a narrow process at the base of each side. The median cusp is nearly as long as the tooth is high, the two cusps on each side of the median are half as long as the median, while the outermost cusp at each end of the cutting margin is rudimentary. The single lateral, as we think it should be called, has a characteristic bow-shape and lies at right angles to the long axis of the lingual ribbon, and bears on the first third of its cutting margin a series of well-developed cusps, 8 or 9 in number. The 3rd or 4th cusps from the inner end of the tooth is enlarged, much longer and sharper than the cusps on either side of it. The series outside the enlarged cusp usually consists of five cusps, progressively smaller as the base of the tooth is reached. The cusps on the inner side of the enlarged one are usually relatively larger than those on the outer side. The marginals are shorter than the lateral and lie parallel to the latter, and have sharp and narrow cusps on both edges of the tooth, those on the outer edge being slightly more numerous.

Holotype. M. $\frac{14310}{2}$ Zoological Survey of India, Indian Museum, Calcutta.

Remarks.—The only representative of the species was found living firmly attached to the shell of *Trochus niloticus* collected at N. W. Ross, Port Blair, Andamans. The removal of the animal without damage, to it from the shell of *T. niloticus* was attended with considerable difficulty and it was found that a saucer-shaped excavation corresponding in outline to that of the shell, and about 2 mm. in depth had been made on the periostracal layer by the close apposition of this Gastropod to the outer surface of the shell of *Trochus niloticus.* The commercial value of *Trochus* is diminished by the excavations in the periostracal, and more rarely, in the ostracal layers of the shell made by such epizoic forms as *Vermetus* (*Spiroglyphus*) *andamanicus* Prashad and Rao and the species described in the present paper.

EXPLANATION OF PLATE I.

Patella (Patellidea) tara, sp. nov.

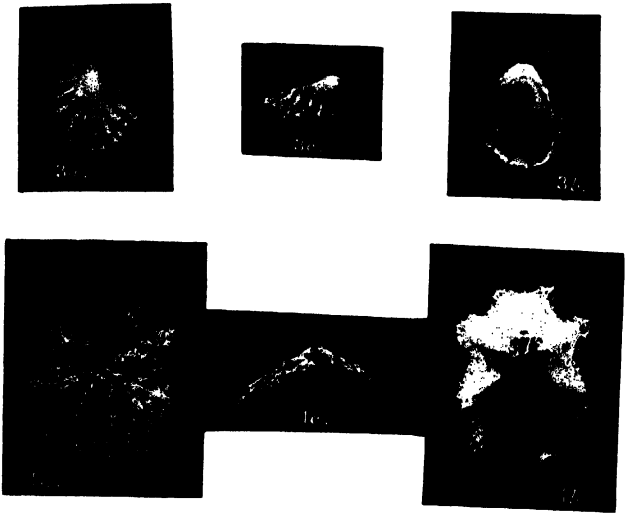
FIGS. 1*a*-1*c*, dorsal, ventral, and lateral views of the holotype ($\times 2\frac{1}{2}$).

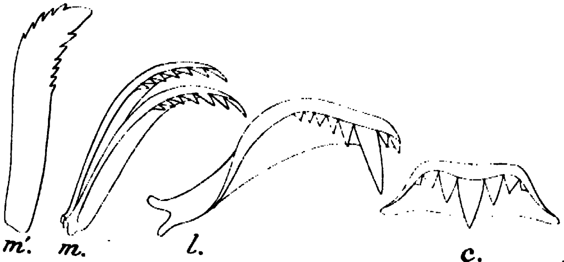
FIG. 2.—Radular teeth—*c.* central; *l.* outer lateral; *l'.* inner laterals; *l''.* side view of an inner lateral; *m.* marginals. ($\times 250$).

Saptadanta nasika gen. *et.* sp. nov.

FIGS. 3*a*-3*c*, dorsal, ventral, and lateral views of the holotype. ($\times 2\frac{1}{2}$).

FIG. 4.—Radular teeth—*c.* central; *l.* lateral; *m.* marginal; *m'.* side view of outer marginal ($\times 250$).





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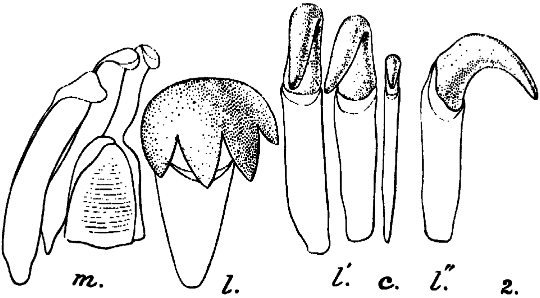

2.

New Limpet-like Gastropods.

ON A NEW SPECIES OF THE GENUS *SEPTARIA* FÉR. FROM VALLAR RIVER, S. INDIA.

By B. PRASHAD, *D.Sc., F.R.S.E., F.A.S.B., Director, Zoological Survey of India.*

(PLATE II.)

Recently Mr. R. V. Seshaiya, Lecturer in Zoology of the Annamalai University, sent me for identification two specimens of a *Septaria* from the Vallar River, about two miles from the sea at Porto Novo. These specimens do not agree with any previously known species of the genus and are described below under the name *Septaria dravidica*, sp. nov.

In his valuable monograph[1] of the genus *Navicella*=*Septaria*, the late Prof. E. von Martens recorded from the Indian area the following 3 species: *Navicella suborbicularis* Sow. (with *N. squamata*[2] Dohrn from Andamans, Nicobar and Ceylon as a synonym), *N. reticulata* Reeve from Ceylon (with *N. livesayi* Dohrn from Ceylon as a synonym) and *N. caerulescens* Sowerby (with *compressa* Benson as a variety) from the River Ganges. Preston[3] considered all the species as distinct and recorded *Septaria reticulata* (Reeve), *S. livesayi* (Dohrn) and *S. squamata* (Dohrn) from Ceylon and *S. compressa* (Benson) and *S. caerulescens* (Sowerby) from the River Ganges and its tributary Hughli in Bengal.

As is clear from the above references, no species of the genus has so far been recorded from Peninsular India and it is, therefore, of special interest to find a species living near Porto Novo in the Vallar River. The new species, as noted above, does not agree with any of the previously known Indian forms, but it differs in so far the shape of its septum is concerned, from all other known species of the genus.

Recluz[4] in his account of the genus divided the species into 3 groups, (i) Sommet saillant au-delà de la marge, souvent corrodé ; (ii) A sommet submarginal entier ; (iii) A sommet situé un peu avant le bord postérieur. The brother Adams[5] adopted for these groups the name *Catillus* Humphrey and the subgeneric names *Septaria* Fér. and *Elara* H. and A. Adams. Gray[6] taking into consideration the form of the operculum and the septum divided the family Navicellidae as he designated it, into 3 tribes and 4 genera—*Catillus, Paria, Stenopoma* and *Orthopoma*. E. von Martens[7] arranged the species of the genus into three groups, and these groups have been adopted by Thiele[8] in his valuable "Handbuch". The three groups are (i) *Septaria* s. s., with an elongated,

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[1] Martens, E. von—Navicella in *Martini and Chemnitz Conch.-Cab.* (N. F.), 11 (10), pp. 1-40, pls. i-vi (1881), pp. 41-56 (1882). The dates of publication of the last two plates, vii, viii, are not definite, but they were probably issued in 1882.

[2] *N. squamata* is wrongly spelt as *N. squamala* on p. 31 of von Martens' monograph.

[3] Preston, H. B.—*Fauna Brit. Ind., Freshw. Moll.*, pp. 6-8 (1915).

[4] Recluz, C.—*Journ. Conchyliol.* I, pp. 375, 376 (1850).

[5] Adams, H. and A.—*Gen. Moll.* I, p. 387 (1856).

[6] Gray, J.—*Proc. Zool. Soc. London*, pp. 993-1000 (1867).

[7] Martens, E. von.—*op. cit.*, p. 8 (1881).

[8] Thiele, J.—*Handbuch Syst. Weichtierkunde*, I, p. 76 (1929).

rather strongly arched shell, thick periostracum, apex prominent, projecting beyond the posterior margin of the shell,—Type *S.* (*S.*) *borbonica* Bory St. Vincent; (ii) *Sandalium* Schumacher, shell greatly arched nearly circular, periostracum thin, with distinct markings, apex somewhat raised, hardly projecting beyond the shell margin,—Type *S.* (*S.*) *orbicularis* (Sowerby), and (iii) *Navicella* Lamarck, shell, flat, thin, elongate periostracum, thin; apex sharp, lying mostly in front of the posterior margin of shell,—Type *S.* (*N.*), *tessellata* Lam.

In reference to the septum (Scheidewand) von Martens remarked that its free anteriorly directed edge is often more or less, but generally very slightly, arched backwards in the middle; in *N. freycineti* Sowerby, however, it projects somewhat forwards in the middle line as in most species of the genus *Crepidularia.* In *S. dravadica,* which belongs to the *Navicella* group, on the other hand, the septum is very narrow and its middle region is broadly arched in the form of a semi-circular bay.

It is of interest to remark here that the late Dr. von Martens in his otherwise valuable monograph referred to above has in his descriptions of several species confused the anterior end of the shell with the posterior.

Septaria dravadica, sp. nov.

Shell ovoid; moderately arched; distinctly narrower anteriorly than posteriorly, lateral sides slightly arched; average index of length to breadth 4:3—3:2, height to breadth 1: 3; apex situated near but not projecting beyond the posterior margin. Shell of a yellowish colour cut up by rectangular black spots forming a chequered pattern; in the paratype the dark olive spots are smaller and more numerous and almost obliterate the ground-colour; apex dark violet. Septum comparatively very narrow, less than $\frac{1}{3}$ the length of shell, cut up in the middle along a semicircular area; of a light creamy colour; inner surface of shell light bluish with the pattern of colour-marking shining through it. Operculum (figs. 3, 3*a*) longer than broad, shell-white in colour, rib, narrow, elongated, marginal; lateral area broad, channelled; diagonal process not distinctly marked.

Measurements (in millimetres).

	Holotype.	Paratype.
Length	18	16·2
Maximum breadth	12·5	12
Maximum height	4	4

Holotype No. M. $\frac{14373}{2}$, Paratype No. M. $\frac{14374}{2}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Locality.—*S. dravadica* was collected from the Vallar River, about two miles from the sea at Porto Novo, South India. The species is common about February.

The radula (fig. 4) resembles that of *S. tessellata* (Lam.) figured by von Martens (*loc. cit.*, pl. i, fig. 3).

EXPLANATION OF PLATE II.

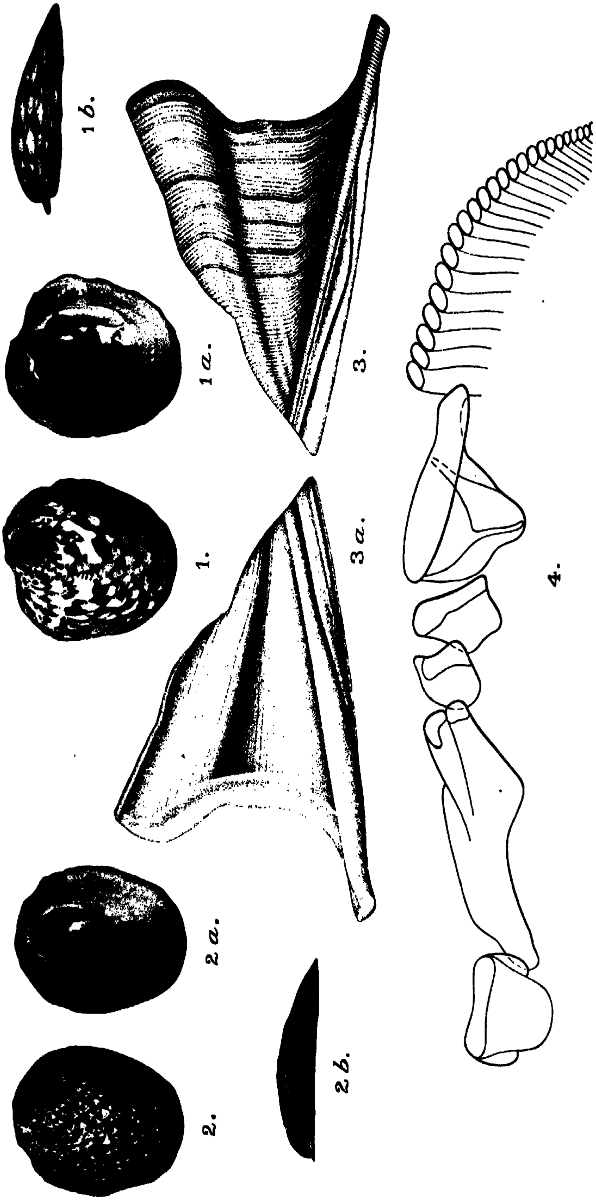
Septaria dravadica, sp. nov.

FIGS. 1, 1*a*, 1*b*.—Dorsal, ventral and lateral views of the Holotype × *Ca.* 2½.

FIGS. 2, 2*a*, 2*b*.—Dorsal, ventral and lateral views of the Paratype × *Ca.* 2½.

FIGS. 3, 3*a*.—Dorsal and ventral views of the operculum × 22.

FIG. 4.—One half row of the radular teeth; only a few of the marginal teeth are shown × 250.



Septaria dravidica, sp. nov.

S. Mondul, delet Photo.

SOME NEW SPECIES OF AVIAN CESTODES FROM INDIA WITH A DESCRIPTION OF *BIUTERINA INTRICATA* (KRABBE 1882).

By M. A. MOGHE, *M.A.*, *M.Sc.*, *F.Z.S.*, AND N. B. INAMDAR, *M.Sc.*,
Department of Zoology, College of Science, Nagpur, C. P., India.

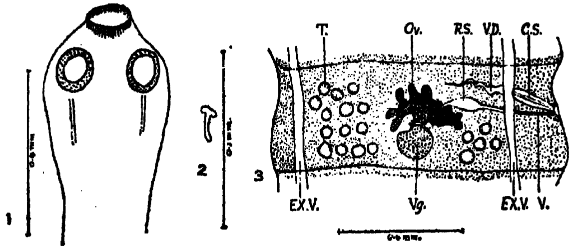
The present paper deals with five new species of cestodes collected from birds in the Central and United Provinces. A detailed description of *Biuterina intricata* (Krabbe 1882) is also appended.

We are greatly indebted to Dr. F. J. Meggitt for helping us with advice and literature for the preparation of this paper, and to the authorities of the Zoological Survey of India, for lending us the necessary references. The type-slides of the various cestodes described in this paper are deposited in the Indian Museum, Calcutta.

Raillietina (Paroniella) molpastina, sp. nov.

Several specimens of this worm were obtained from the intestines of two specimens of the Red-vented Bulbul, *Molpastes haemorrhous* (Gmelin).

Anatomy.—Maximum length of worm about 50-55 mm.; maximum width (posteriorly) about 1·5 mm. All proglottids much wider than long, varying in size from 0·1—0·6 mm. × 0·3—0·5 mm. in various regions of the strobilus. Scolex (fig. 1) 0·3 mm. × 0·35 mm.; rostellum 0·108 mm. in diameter, armed with a double crown of about 180 hooks of the



FIGS. 1-3.—*Raillietina (Paroniella) molpastina*, sp. nov.
FIG. 1.—Scolex.
FIG. 2.—Rostellar hook.
FIG. 3.—Entire mature proglottid.

Davaineid type. The shape of the hooks is shown in fig. 2; each hook is 15μ in length. Suckers 113μ × 93μ; armed with three rows of minute hooks. There is a short unsegmented neck region behind the scolex. Genital pores unilateral, situated a little anteriorly to the middle point of lateral proglottid margin. There are about 19 testes (fig. 3, *T.*) in each proglottid, arranged in two groups, one on either side of the ovary;

NOTE.—Explanation of lettering of text-figures *C. S.* Cirrus sac; *Ex. V.* Excretory vessel; *Ov.* Ovary; *P. U.* Paruterine organ; *R. S.* Receptaculum seminis; *T.* Testis; *U.* Uterus; *V.* Vagina; *V. D.* Vas deferens; *Vg.* Vitelline gland.

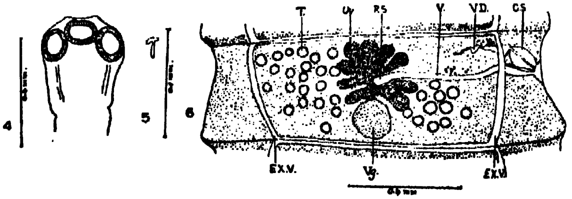
 D

poral group consisting of 5 and aporal of 14 testes; diameter of each testis is 46μ. Cirrus sac (*C. S.*) cylindrical, not extending beyond the lateral excretory vessel of the poral side; 0·14 mm. in length and 0·04 mm. in width at its base; cirrus and its sac both unarmed. Vas deferens (*V. D.*) a straight, slightly coiled tube. Ovary (*Ov.*) slightly poral, lobed. Vagina (*V.*) posterior to the cirrus sac, forming a dilated receptaculum seminis (*R. S.*) near its junction with the ovary. Vitelline gland (*Vg.*) rounded, situated posteriorly to the ovary. Shell gland small. The uterus first appears as an elongated sac on the poral side round about the receptaculum seminis but later includes the sex glands; in fully gravid proglottids it disintegrates into egg capsules, 44μ×33μ, each of which has a single egg; the capsules extend beyond the excretory vessels. Eggs (in canada balsam) have a diameter of about 21μ.

Raillietina (Paroniella) duosyntesticulata, sp. nov.

A few specimens, mostly in pieces, were obtained from the intestine of a specimen of *Xantholaema haematocephala* (Müller).

Anatomy.—The largest piece is 40 mm. long and probably the total length of the worm would be about 60 mm., the maximum width is 2·1 mm. All proglottids wider than long, varying in size from 0·058—0·264 mm.×0·29—2·1 mm. in different regions of strobilus. Genital pores unilateral, situated in the anterior third of the lateral margin of the proglottid. The genital ducts pass between the longitudinal excretory vessels. Scolex (fig. 4) measures 0·68 mm.×0·4 mm. Rostellum 114μ long, with a double crown of 234 Davaineid hooks. The form of the hooks is T-shaped (fig. 5). Each hook 17μ in length. Suckers 140μ ×120μ, armed with 5 rows of minute hooks. The unsegmented neck region is very short. 32-37 testes (fig. 6, *T.*) in each proglottid, situated



FIGS. 4-6.—*Raillietina (Paroniella) duosyntesticulata,* sp. nov.
FIG. 4.—Scolex.
FIG. 5.—Rostellar hook.
FIG. 6.—Entire mature proglottid.

laterally and posterior to the ovary; the poral group consists of 9-14 and the aporal of 23 testes; diameter of each testis 21μ. Cirrus sac (*C. S.*) 96μ×47μ, extending three-fourths the distance between lateral proglottid margin and the poral excretory vessel. Cirrus and its sac both unarmed. Vas deferens (*V. D.*) in the form of a straight coiled tube. Ovary (*Ov.*) slightly aporal, deeply lobed. Vagina (*V.*) only slightly dilated near its junction with the ovary. Vitelline gland (*Vg.*) large, round. Shell gland small. The uterus makes its appearance as a sac round the ovary but later fills the entire proglottid extending

beyond the excretory vessels and breaking up into egg capsules, 11μ × 8μ, and containing a single egg measuring 10μ × 7μ (in canada balsam).

Systematic Position.—Both the worms described above belong to the genus *Raillietina* Führmann 1920, since they possess a rostellum armed with numerous T-shaped hooks, and in both the uterus breaks into egg capsules. The genital pores are unilateral and each of the egg capsules contains a single egg. They, therefore, belong to the subgenus *Paroniella* Führmann 1920. A list of the species of this subgenus was recently published by Führmann (1932); *R. acanthovaginata* Purvis 1932 from a fowl is not included in this list and *Raillietina rangoonica* Subramaniyam (1928), should, in our opinion, also be referred to this subgenus. On referring to the key to the species of *Davainea* by Meggitt (1921) and the descriptions of these species given by Lopez-Neyra (1931) while proposing a new classification for this group of cestodes which, however, is not accepted by Baer (1931) and Führmann (1932), it is found that *R.* (*P.*) *sphecotheridis* has accessory rostellar spines, *R.* (*P.*) *magninumida* and *R.* (*P.*) *urogalli* both possess an armed cirrus, *R.* (*P.*) *reynoldsae* has a spiny collar on the scolex, the rostellar hooks in *R.* (*P.*) *rhynchota* form a rosette with eight limbs, *R.* (*P.*) *facile* has a very small number (9) of testes, *R.* (*P.*) *numida*, *R.* (*P.*) *compacta*. *R.* (*P.*) *cruciata* have a relatively longer cirrus sac, *R.* (*P.*) *fecunda* has a larger number of rostellar hooks of a smaller size, *R.* (*P.*) *paradisea* has a larger number of testes, the cirrus sac is relatively smaller in *R.* (*P.*) *corvina* and a smaller number of rostellar and a larger number of acetabular hooks, *R.* (*P.*) *rangoonica* has smaller rostellar hooks and fewer testes and finally *R.* (*P.*) *acanthovaginata*[1] has a larger number of rostellar hooks of a smaller size and a larger cirrus sac. It is, therefore, evident that the two worms described above differ from all other known species of this subgenus. Unfortunately we have not been able to consult the descriptions of *R.* (*P.*) *conopophilae* and of *R.* (*P.*) *polycalcaria*, both from Passeriform birds.

SPECIFIC DIAGNOSES.

Raillietina (Paroniella) molpastina, sp. nov.

Length 50-55 mm., maximum width 1·5 mm.; scolex with a double crown of 180 hooks on the rostellum, length of each hook 15μ; suckers armed with three rows of minute hooks; testes 19 in number, each 46μ in diameter; cirrus sac just reaching the lateral excretory vessel of the poral side; eggs (in canada balsam) 21μ × 20μ.

Host.—Red vented Bulbul, *Molpastes haemorrhous* (Gmelin).

Habitat.—Intestine.

Locality.—Nagpur, C. P., India.

Raillietina (Paroniella) duosyntesticulata, sp. nov.

Length about 60 mm., maximum width 2·1 mm.; rostellum armed with 234 hooks, each 17μ in length; suckers armed with 5 rows of minute hooks; cirrus sac extends to a distance equal to three-fourths the dis-

[1] We are indebted to Dr. F. J. Meggitt for furnishing us with a description of *R.* (*P.*), *acanthovaginata* Purvis 1932.

tance between the lateral proglottid margin and the poral lateral excretory vessel; eggs (in canada balsam) 10µ×7µ.

Host.—*Xantholaema haemacephala* (Müller).

Habitat.—Intestine.

Locality.—Nagpur, C. P., India.

Ophryocotyloides monocantis, sp. nov.

One flattened and six unflattened specimens of this cestode collected from a Tree Pie, *Dendrocitta rufa* (Scop.). We are indebted to Mr. S. C. Verma of the Zoological Department, University of Allahabad, for this material.

Anatomy.—Total length of the worm 40 mm. with a maximum width 2·42 mm. The entire strobilus consists of about 500 proglottids varying in size from 0·024—0·701 mm.×0·22– 1·5 mm. in different regions of the strobilus. All proglottids wider than long. Genital pores unilateral. Scolex (fig. 7) of the Davineid type ; 0·2 mm. in length, with a maximum width of 0·285 mm. Rostellum, 0·1 mm.×0·043 mm., armed with two rows of minute hooks, each hook being 8µ in length. Suckers, 0·122 mm.×0·108 mm., armed with three rows of minute hooks. 30 to 35 testes (fig. 8, *T*), of a diameter of 60µ, in each proglottid, situated laterally

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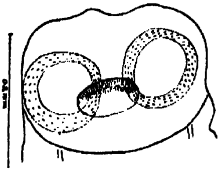

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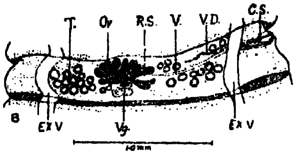


FIGS. 7-8.—*Ophryocotyloides monocantis*, sp. nov.
FIG. 7.—Scolex.
FIG. 8.—Entire mature proglottid.

and posteriorly to the ovary. There is approximately an equal number of testes on each side of the ovary. Cirrus sac small, just reaching the nerve, 0·128 mm. long and 40µ broad at its base. It contains a straight unarmed cirrus, which is continued into a straight vas deferens (*V. D.*). Ovary (*Ov.*) slightly aporal, occupying more than half the length of proglottid and almost more than a third of the width between the lateral excretory canals. In a fully mature segment, the ovary is still larger and occupies the entire length and half the width of the proglottid. Receptaculum seminis present. Vitelline gland (*Vg.*) rather small; shell gland still smaller. Uterus sac-like, occupying the whole proglottid, extending beyond the lateral excretory vessels nearly up to the lateral proglottid margins; persistent and not breaking into egg capsules. The eggs (in canada balsam) 27µ×21µ; embryos 11µ×9µ.

Systematic position.—The presence of a rostellum armed with Davaineid hooks and a persistent uterus place this worm in the subfamily Ophryocotylinae Führmann 1907, and owing to the unilateral genital pores it has to be referred to the genus *Ophryocotyloides* Führmann 1920. This species differs from others (*vide* table of characters

the testes. No receptaculum seminis. Vitelline gland (*Vg.*) situated posteriorly to ovary. The uterus at first appears as a narrow elongated sac round about the testes but later spreads and occupies the entire proglottid. (Fig. 12.) Eggs (in canada balsam) 21μ×20μ and the onchospheres 10μ×9μ.

Discussion.—The presence of rostellum armed with 10 hooks of the Hymnolepid type and the presence of two testes in each proglottid, place this worm in the subfamily Hymenolepidinae and in the genus *Diorchis.* A list of the species of *Diorchis* is given by Führmann (1932) while descriptions of the species except of *D. longicirrosa* Meggitt 1927, in which the hooks are absent and in which both the testes are aporal to the ovary and of *D. spiralis* Szpotanska 1931, were published by Mayhew (1929).

The species herein described resembles *D. spinata* Mayhew (1929), *D. kodonoides* Mayhew (1929) and *D. spiralis* Szpotanska (1931) in having a long cirrus sac, but it can be distinguished from *D. spinata* Mayhew, and *D. kodonoides* Mayhew in having longer rostellar hooks and from *D. spiralis* Szpotanska in the absence of a spiral sphincter muscle on the vaginal aperture. We regard it, therefore, as a new species and propose the name *Diorchis magnicirrosa*, with the following specific diagnosis :—

Length 225 mm., maximum width 0·65 mm. ; rostellum 0·224×0·165 mm., rostellar hook 60μ in length ; suckers 0·160×0·128 mm. ; ovary between the two testes ; cirrus sac reaching beyond the centre of the proglottid. Eggs (in canada balsam) 21μ×20μ.

Host.—Dove.

Habitat.—Intestine.

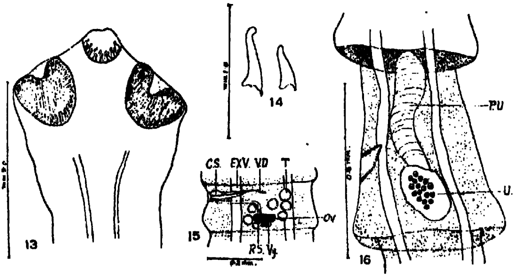
Locality.—United Provinces, India.

Paruterina septotesticulata, sp. nov.

Five scolices and several pieces were found in the intestine of *Coracias indica* (Linn.). These on examination proved to be a new species of the genus *Paruterina* Führmann 1906. No species of this genus has so far been recorded from Coraciiformes (*vide* list by Führmann 1932), and no species has so far been recorded from India (Southwell 1930).

Anatomy.—Total length of worm probably 55 to 60 mm. with a maximum width of 0·638 mm., approximately 200 proglottids. The gravid proglottids are the longest, 0·695×0·537 mm., while the early gravid proglottids are the widest, 0·221 mm.×0·638 mm., the measurements of mature proglottids are 0·157 mm.×0·406 mm. Scolex (fig. 13) 0·429 mm. in length and 0·663 mm. in maximum width, forms the broadest part of the entire worm. Rostellum, 0·132 mm. in diameter, armed with 32 hooks arranged in two rows. The hooks of the two rows have the shape shown in figure 14, and measure 43μ and 31μ respectively. Suckers nearly globular, 0·246 mm. in diameter. The scolex is followed by an unsegmented region, 0·472 mm. in length. Genital pores irregularly alternating, genital ducts lying between the longitudinal excretory vessels. Seven testes (fig. 15 *T*) in each proglottid, arranged in two groups situated laterally and posteriorly to ovary ; three testes poral, four aporal, each 37μ in diameter. Cirrus sac (*C. S.*) 0·151 mm. in length and 31μ in width at its base, extending beyond the poral lateral

excretory vessel. Vas deferens (*V. D.*) simple, narrow, wavy. Vagina a narrow tube opening into a genital atrium, near the ovary slightly dilated to form a small receptaculum seminis (*R. S.*). Ovary (*Ov.*) slightly aporal. Small vitelline gland (*Vg.*) situated posterior to ovary. The uterus commences to appear as a sac round the female complex and in its fully formed condition, forms a spherical sac in the middle of the proglottid nearer its posterior border and is anteriorly attached to a paruterine organ (fig. 16, *P. U.*) in which the eggs finally pass. The



FIGS. 13-16.—*Paruterina septotesticulata*, sp. nov.
FIG. 13.—Scolex.
FIG. 14.—Rostellar hook.
FIG. 15.—Entire mature proglottid.
FIG. 16.—Entire gravid proglottid.

eggs, in the paruterine organ, are all stored up at one place, forming a compact mass, round which the paruterine organ is specially dilated. This dilatation is near the uterus and thus is not an anterior dilatation as in *Sphaeruterina* Johnston 1914. The eggs (in canada balsam) are 23μ in diameter and the contained onchosphere 14μ in diameter.

Discussion.—The presence of a rostellum armed with a double row of Hymenolepid hooks and a longitudinally elongated paruterine organ places this worm in the subfamily Paruterininae Führmann 1907, and in the genus *Paruterina* Führmann 1906. A list of the species of this genus is given by Führmann (1932) and a table of characters of most of these species by Skrjabin (1914). *P. angustata* Führmann 1906, and *P. guinensis* Joyeux & Baer 1928, have unilateral genital pores and thus form a group by themselves. Of the remaining species of *Paruterina* with irregularly alternating genital pores, *P. melierax* (Woodland 1929) Johri (1931), has an unarmed rostellum and a large number of testes (50 to 60). *P. candelabraria* (Goeze 1782) Führmann 1906, *P. meggitti* Johri 1931, *P. cholodkowskii* Skrjabin 1914, *P. sinensis* (Ransom 1909) Linton 1927, *P. otidis* Baczynska 1914, *P. bucerotina* Führmann 1909, are all characterised by the possession of a larger number of hooks and a larger number of testes than found in the species described in this paper. We could not get any reference to the number of testes in *P. parallelipipeda* (Rudlophi 1810) Führmann 1908, and *P. vesiculigera* (Krabbe 1882) Führmann 1926, but in the former the number of hooks is fewer (19), while in the latter it is larger (50) than in the species described here. *P. fuhrmanni* Baczynska 1914 has been transferred to the genus *Sphaeru-*

terina Johnston 1914, by Führmann (1932) because of a distinct anterior dilatation of the paruterine organ. The species described above thus differs from other species of *Paruterina* and we propose for it the name *Paruterina septotesticulata* with the following specific diagnosis :—

Length 55 to 60 mm.; maximum width 0·638 mm.; scolex 0·429 mm.×0·663 mm.; diameter of rostellum 0·132 mm., armed with 2 rows of 32 hooks, each 43μ and 31μ in length respectively; diameter of sucker 0·246 mm.; testes 7, each 37μ in diameter. Eggs (in canada balsam, 23μ and onchospheres 14μ in diameter.

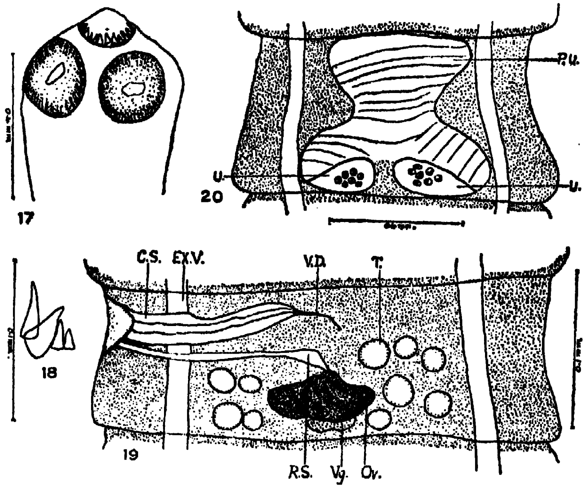
Host.—*Coracias indica* (Linn.)

Habitat.—Intestine.

Locality.—Nagpur, C. P., India.

Biuterina intricata (Krabbe 1882).

The description of *Biuterina lobata* Führmann (1908) was based on material which contained only gravid proglottids. According to him the uterus consists of two portions, a character which is common to all the species of the genus. He further suggested, though querying



FIGS. 17-20.—*Biuterina intricata* (Krabbe 1882).
FIG. 17.—Scolex.
FIG. 18.—Rostellar hook.
FIG. 19.—Entire mature proglottid.
FIG. 20.—Entire gravid proglottid.

Krabbe's description, that *Taenia intricata* Krabbe 1882 was probably identical with *Biuterina lobata* Führmann 1908. Krabbe's species is characterised by having four rows of rostellar hooks and was found parasitic in an Upupiformes bird, *Upupa epops* Linn. which is the identical host for *Biuterina lobata*. Our material was also obtained from

the same host and consists of about 7 complete worms. We give below a complete description of this worm.

Anatomy.—Total length of worm about 50 to 55 mm. with a maximum width of 0·3 mm. All proglottids broader than long; mature proglottids 0·1 mm.×0·22 mm. Genital pores irregularly alternating, genital ducts pass between the longitudinal excretory vessels. Scolex (fig. 18) 0·43 mm. wide at its base. Rostellum 0·102 mm.×0·203 mm. with four rows of 64 hooks of different lengths; they measure: 0·052 mm., 0·036 mm., 0·030 mm., and 0·0196 mm. in diameter. A considerable portion of the strobilus behind the scolex is unsegmented. Ten testes (fig. 19, *T*) in each proglottid: 4 poral, six aporal of the ovary. Cirrus sac (*C. S.*) 0·107 mm. in length, with a straight unarmed cirrus. Vas deferens (*V. D.*) a very compact coiled mass. Ovary (*Ov.*) situated centrally towards the posterior end of the proglottid. Vitelline gland (*Vg.*) compact, in close neighbourhood of the ovary posteriorly. Vagina (*V.*) a straight canal, opening in genital atrium posterior to cirrus sac; near the ovary it is dilated into a small bulb-like receptaculum seminis. Uterus (fig. 20) in all gravid proglottids appears as a double sac near the posterior border of the proglottid. The eggs pass into a paruterine organ which has the same appearance as that which is figured by Führmann (1908). Eggs (in canada balsam) 27μ×22μ.

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ON THE STOMATOPOD CRUSTACEA COLLECTED BY THE BENGAL PILOT SERVICE OFF THE MOUTH OF THE RIVER HUGHLI, TOGETHER WITH NOTES ON SOME OTHER FORMS.

By B. CHOPRA, D.Sc., *Zoological Survey of India, Calcutta.*

Since the publication of the paper entitled "Notes on Stomatopoda"[1] by Kemp and myself in 1921, a considerable number of specimens have accumulated in the collection of the Zoological Survey of India, and as a large number of these have been collected by members of the Bengal Pilot Service at the Sandheads, off the mouth of the *Hughli River*, it has been thought desirable to publish a short note on this collection. Most of these specimens belong to species already known to live in this area, but there are some that are being recorded from this locality for the first time. Though none of the latter records materially extend the geographical range of the species, those of the comparatively rarer forms are of interest. Opportunity has also been availed of to include observations on some other species (pp. 31-43), examples of which have recently been acquired by the Zoological Survey of India. Most of these have been collected by the R. I. M. S. "Investigator" in the Bay of Bengal. No mention is made of the commoner forms in this collection; only those species being noticed that are either somewhat rare, or the fresh records of which are remarkable from the point of distribution, etc. I have also examined two small collections sent to me for identification by the Raffles Museum, Singapore. These, for the most part, consist of very common species, chiefly belonging to the *nepa* group of *Squilla*, which do not require any special mention, but one rather uncommon form, *Squilla lirata* Kemp and Chopra, has been noticed.

The physical conditions prevailing at the Sandheads have been briefly mentioned in an earlier paper[2]. This area lies roughly in 21°N. and 88°E., and though for all practical purposes is a part of the open sea, the salinity is somewhat lower than that of the outlying parts of the Bay of Bengal. The depth in most places is about 20 fathoms, and the bottom consists of soft mud, or, in some places, of sand and mud.

Several species of Stomatopoda have already been recorded from the Sandheads by Wood-Mason[3] and Kemp[4]. All these species belong to the genus *Squilla*; none of the other genera have been collected, until recently, in this locality. The following species are mentioned in Kemp's memoir as having been obtained at the Sandheads :—

Squilla latreillei (Eydoux and Souleyet).
Squilla scorpio var. *immaculata* Kemp.
Squilla nepa Latreille.

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[1] Kemp and Chopra, *Rec. Ind. Mus.* XXII, pp. 297-311 (1921).
[2] Chopra, *Rec. Ind. Mus.* XXXV, pp. 25, 26 (1933).
[3] Wood-Mason, *Figs. and Desc. of nine Squillidae*, pp. 1-11, pls. i-iv (Calcutta: 1895).
[4] Kemp, *Mem. Ind. Mus.* IV, pp. 1-217, pls. i-x (1913).

Squilla holoschista Kemp.
Squilla oratoria var. *inornata* Tate (=var. *perpensa* Kemp).
Squilla interrupta Kemp.
Squilla wood-masoni Kemp.
Squilla raphidea Fabricius.

All these species, with the exception of *Squilla scorpio* var. *immaculata*, are represented in the present collection. Besides these the following species, not hitherto recorded from the Sandheads, are also in the collection :—

Squilla decorata (Wood-Mason).
Squilla gilesi Kemp.
Squilla annandalei Kemp.
Lysiosquilla maculata (Fabricius).
Lysiosquilla acanthocarpus Miers.

The Stomatopod fauna of the Sandheads, as known at present, thus consists of thirteen species ; eleven of these belong to the genus *Squilla*, while two are referable to *Lysiosquilla*. No representatives of *Pseudosquilla* Dana, *Hemisquilla* Hansen, *Gonodactylus* Latreille, *Odontodactylus* Bigelow, *Cornida* Brooks and *Cornidopsis* Hansen have hitherto been collected, and judging from the fact that members of at least the four first mentioned of these genera prefer a rough ground, like oyster beds and coral reefs, it seems probable that they do not inhabit this locality at all. The habits of *Cornida* and *Cornidopsis* are very little known, and it is difficult to say anything about the likelihood or otherwise of the species of these genera ever being collected at the Sandheads. Of the species of *Squilla* that live in this locality *S. interrupta* Kemp is the form most commonly met with, the next two in the order of abundance being *S. raphidea* and *S. nepa*. The remaining eight species are only occasionally met with in this area, and are represented in the collections by one or two examples of each. The two species of *Lysiosquilla* are also, in point of numbers, poorly represented in the collections from the Sandheads, but as members of this genus usually live in deep burrows out of which they do not go very far, it is possible that their scarcity is more apparent than real.

There are two larval forms also included in the collection from the Sandheads, but as I am unable to refer them to their species with any degree of certainty, I have not mentioned them in the following account.

There has been a considerable difference of opinion regarding the advisability of using the generic designation *Squilla* in the Stomatopoda, *Chloridella* Miers having been suggested in its place, chiefly by some American zoologists, headed by the eminent carcinologist Miss Mary Rathbun. The principal argument in favour of abandoning the former name is that the first post-Linnean use of *Squilla* as a generic designation appears to have been in a group other than the Stomatopoda. Even if this view is found to be correct—though most of the recent workers, including Stebbing, Kemp, Hanson and Bigelow, have not subscribed to it—it is difficult to justify the employment of *Chloridella* in place of *Squilla*.

Eydoux and Souleyet[1] in 1841 separated the small-eyed group of Squillas under the name of *Clorida* (not *Chlorida*); but as Miers[2] in 1880 found that the designation *Chlorida* had already been used in the Coleoptera, he suggested the name *Chloridella* to replace the one employed by Eydoux and Souleyet. The reference to the use of *Chlorida* in the insecta is no doubt due to Audinet-Serville[3], who, in 1834, had set up a genus of Cerambicidae, with *Chlorida costata* as the type-species. According to Brooks[4] and all later workers, however, *Chloridella* Miers (or *Clorida* Eydoux and Souleyet) could not be maintained as distinct from *Squilla*, and it, thus, became a synonym of the latter. Miss Rathbun[5] in 1902 pointed out that as the first use of *Squilla* as a generic name after 1st January, 1758, was for an Amphipod, the retention of this name in the Stomatopoda could not be permitted under Article 26 of the International Code, and suggested the use of Miers' *Chloridella* in its place. But in view of the Recommendations under Article 36 of the Code (see also Opinion 25) *Clorida* cannot be rejected on account of a somewhat similar name, *Chlorida*, having been pre-occupied, and if it was found necessary to discard *Squilla*, the name to replace it should have been *Clorida*, and not *Chloridella*.

Bigelow[6] has recently given a very clear exposition of the whole case, and I quite agree with him that even though by the strict application of the laws of priority there may be some justification for abandoning *Squilla* as a generic designation in the Stomatopoda, such a course will only result in greater confusion rather than in uniformity. The retention of this name for the present, at any rate, is especially to be commended in view of the fact that Bigelow states that he is presenting a petition to the International Commission on Zoological Nomenclature to declare *Squilla* as a *nomen conservandum*. If by an adverse decision of the Commission this old and well-known name has after all to be given up, *Clorida* Eydoux and Souleyet should, in my opinion, take its place.

In the present paper I have followed the arrangement of species, etc., as given by Kemp[7] in his well-known monograph on the Indo-Pacific Stomatopoda, which still remains the most standard work on this group. In giving synonymies also I have mostly cited this work alone, giving, wherever necessary, references to some later important works only. Among these may be mentioned Komai's[8] valuable contribution on the Japanese forms, and Bigelow's[9] recent masterly work on the Southern and Eastern Pacific Stomatopoda. Hansen's[10] excellent account of the Stomatopods collected by the Siboga Expedition also deserves special mention.

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[2] Miers, *Ann. Mag. Nat. Hist.* (5) V, p. 13, foot-note (1880).
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[4] Brooks, *Challenger Stomatopoda* (Zool. XVI), pp. 22, 23 (1886).
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[9] Bigelow, *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 103-191, pls. i, ii (1932).
[10] Hansen, *Siboga Exped. Rep.* XXXV, pp. 1-48, pls. i, ii (1926).

Squilla latreillei (Eydoux and Souleyet).

1913. *Squilla latreillei*, Kemp, *Mem. Ind. Mus.* IV, pp. 24-27, pl. i, figs. 1-4.
1927. *Squilla latreillei*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, pp 308, 309.
1930. *Squilla latreillei*, Gravier, *Bull. Mus. nat. Paris* (2) II, p. 524.

I refer to this species one female specimen collected by the Pilot Vessel " Lady Fraser " at the Sandheads in 1923. It agrees very closely with Kemp's description of the species, as also with named examples in the collections of the Indian Museum. The carapace, as mentioned by Kemp, and as shown in the figures given by Eydoux and Souleyet[1] and Wood-Mason[2] is of a triangular shape. In the Sandheads example the length of the carapace, excluding the rostrum, is 7·8 mm., while its breadth at the antero-lateral angles, which are produced into sharp spines, is only 4·2 mm. The carapace is, however, broadest a little in front of the rounded postero-lateral angles, where the breadth equals almost exactly the length. In some other examples in the Museum collection that I have examined the proportions are also more or less similar. The carinae on the carapace are very poorly developed, and are as described by Kemp.

In the specimen from the Sandheads the raptorial claw of one side is missing, the dactylus of the other side has only four teeth, including the terminal one.

The telson is as described and figured by Kemp and other authors, but the tubercles and ridges on the dorsal surface are almost as well developed as shown in Kemp's figure of the Persian Gulf female, and not like those shown in Wood-Mason's figure. Of the two other females from the Sandheads in the Museum collection, one, acquired after the publication of Kemp's memoir, has the tubercles well developed, while in the other the condition is like that shown in Wood-Mason's figure.

The colour of the specimen is as described by Komai, except for the fact that the mottling on the carapace is more extensive and the posterior border of the fifth thoracic somite is not bordered with black. The black border on the posterior margin of the last abdominal somite is very inconspicuous.

The species was originally described from Singapore, and besides the localities mentioned by Kemp, has now been recorded from the coast of Annam and Nagasaki in Japan. The species has thus a very wide range of distribution, having been met with in the Persian Gulf on the west to as far east as the south of Japan. At the Sandheads it appears to be not uncommon, having been collected there on four different occasions. The single specimen in the present collection is registered as under :—

C 1652/1	Sandheads, off the mouth of the Hughli River.	" Lady Fraser ", 5.xi.1923.	1 ♀, 46 mm.[3]

[1] Eydoux and Souleyet, *Voyage " Bonite"*, Zool. Crust., p. 265, pl. v, figs. 2-5 (1841).
[2] Wood-Mason, *Figs. and Desc. of nine Squillidae*, pl. iv, figs. 6-13 (Calcutta : 1895).
[3] The length of specimens given is from the tip of the rostrum to the posterior extremity of the telson.

Squilla decorata (Wood-Mason).

1913. *Squilla decorata*, Kemp, *Mem. Ind. Mus.* IV, pp. 27, 28, pl. i, figs. 13-16.

One large female specimen from the Sandheads is referred to this rather rare species.

C 1653/1	Sandheads, off the mouth of the Hughli River.	"Lady Fraser", June, July, 1927.	1 ♀, 77 mm.

Except for one or two minor differences the present specimen agrees closely with the mutilated type-specimen and with other named examples in the Museum collection. In the Sandheads specimen the following carinae end in spines :—

Carinae.	Abdominal somites.
Submedian	6.
Intermediate	2, 3, 4, 5, 6.
Lateral	3, 4, 5, 6.
Marginal	2, 3, 4, 5.

It is thus seen that in the Sandheads specimen more carinae end in spines than is typically the case. In other examples in the Indian Museum collection, as shown in the table given by Kemp, the intermediate carina of the second abdominal somite never ends in spine, while that of the third sometimes does so ; in the Sandheads example the intermediate carina terminates in spine on both these somites. Similarly the lateral and the marginal carinae of the third and the second abdominal somites respectively end in distinct spines in my specimen from the Sandheads.

As mentioned by Kemp and shown in his figure, as also in those given by Wood-Mason[1], the marginal teeth of the telson are without any serrations on their edges. In the example from the Sandheads the outer edge of the intermediate tooth on the margin of the telson is distinctly serrate. The serrations are not quite so well developed as those in *Squilla latreillei*, but they can be seen quite distinctly, especially on the basal half of the tooth. Another specimen in the Museum collection, from off the Irrawady Delta, also shows faint indications of similar serrations.

Squilla decorata is so far known from the Bay of Bengal only. The type-specimen, from which Wood-Mason described the species, was collected in the Andamans, and Kemp recorded three other examples from off the Burma coast. One of the latter, from off Akyab, was included in the species somewhat doubtfully. Another specimen from Jack and Una Island, Mergui Archipelago, was referred to the species by Kemp and myself[2] in 1921. All the specimens so far known are females.

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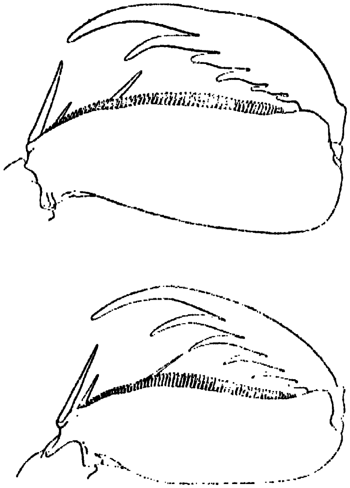
[1] Wood-Mason, *Figs. and Desc. of nine Squillidae*, p. 9, pl. iv, figs. 14-17 (Calcutta : 1895).

[2] Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 295 (1921).

Squilla gilesi Kemp.

1913. *Squilla gilesi*, Kemp, *Mem. Ind. Mus.* IV, pp. 39, 40, pl. ii, figs. 25-27.

As pointed out by Kemp, *Squilla gilesi* resembles very closely *Squilla lata* Brooks[1], but with the help of the characters given by Kemp the two can be specifically distinguished without much difficulty. In *S. gilesi* the submedian carinae are present on the last thoracic and all the abdominal somites, and the inner margin of the bifurcate process of the



a

b

TEXT-FIG. 1.—*Squilla gilesi* Kemp.

Two terminal segments of raptorial claw of

a. male, *b*. female.

uropod bears only a series of serrations, instead of the well-developed spines that are present in Brooks' species; these two characters alone, apart from the others mentioned by Kemp, are sufficient to recognise the present species.

[1] As pointed out by Kemp it is somewhat doubtful whether the Indian specimens referred by him to *S. lata* Brooks really belong to this species. The Indian examples show some fairly important differences from Brooks' description of the species, and if these are found to be constant on an examination of further material, it will probably be necessary to give a new name to the Indian form. Komai [*Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, pp. 310, 311, pl. xiv, fig. 1 (1927)] has recently shown that in a Japanese example that he referred to Brooks' species, the mandibular palp is completely suppressed, the post-anal carina is absent, and, as in Brooks' examples, none of the carinae on the thoracic and first four abdominal somites (first five in the case of Brooks' specimens) ends in a spine. If Komai's example has been correctly identified, the Indian specimens certainly represent a distinct species. A re-examination of the Challenger material with reference to the mandibular palp and the post-anal carina can only clear this point.

I refer to this species three specimens from the Sandheads:—

C 1654/1	Bay of Bengal, between Pilot Ridge Light Vessel and Eastern Channel Light Vessel; 10 miles N. and S. of Eastern Channel Light Vessel.	"Fraser", Nov., 1923.	1 ♂, 82 mm.
C 1655/1	Sandheads, off the mouth of the Hughli River.	"Lady Fraser", Feb., March, 1928.	1 ♂, 1 ♀, 66 and 68 mm.

The smaller male is without raptorial claws, but the secondary sexual characters on the telson, mentioned by Kemp, are very clearly seen. The proximal tooth on the dactylus of the raptorial claw is greatly reduced in both the other examples, and the claw in the male shows the secondary characters very distinctly.

Squilla gilesi is so far known from the Indian waters only, from both the Bay of Bengal and the Arabian Sea. The types, from off the Madras coast, were collected at a depth of 80-110 fathoms.

Squilla nepa Latreille.

1913. *Squilla nepa*, Kemp, *Mem. Ind. Mus.* IV, pp. 60-64, pl. iv, fig. 49.
1926. *Squilla nepa*, Hansen, *Siboga Exped. Rep.* XXXV, pp. 10, 11.
1927. *Squilla nepa*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 314.

Squilla nepa appears te be a fairly common species at the Sandheads, 14 specimens of it, collected between the years 1923 and 1932, having been brought back by members of the Bengal Pilot Service. Of these five are males and nine females, and, excluding a very young female 23 mm. long, range in size from 51 to 76 mm. Besides these there are a number of specimens from the same locality in the older collections also.

The species occurs commonly in Indian coastal waters, having been extensively met with both in the Arabian sea and the Bay of Bengal. It has a very wide range of distribution over the Indo-Pacific area, extending, according to Kemp, from Honolulu to Madagascar and Durban. Komai has recorded it from Formosa, which he believes "may be almost the northern limit of distribution of the species". The occurrence of this species in brackish waters, as recorded by Kemp[1] and Komai, is of interest.

Squilla holoschista Kemp.

1913. *Squilla holoschista*, Kemp, *Mem. Ind. Mus.* IV, pp. 64, 65, pl. iv, figs. 50-53.
1921. *Squilla holoschista*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 301.

I refer to this species four specimens from the Sandheads. Of these two are males and two females, and in size range from 64 to 77 mm.

Except for the specimens recorded by Sunier[2] from the Sunda Straits, the species is so far known to occur only along the east coast of India, where it is met with extensively from the Delta of the Ganges to Ceylon.

[1] Kemp, *Mem. As. Soc. Bengal* VI, p. 297 (1918).
[2] Sunier, *Contrib. Faune Indes Neerland.* IV, p. 69 (1918).

Squilla oratoria var. inornata Tate.

1883. *Squilla inornata*, Tate, *Trans. Roy. Soc. S. Aust.* VI (for 1882), p. 51, pl. ii, figs. 3*a*, *b*, *c*.
1913. *Squilla oratoria*, var. *perpensa*, Kemp, *Mem. Ind. Mus.* IV, pp. 66-68, pl. v, figs. 57-59.
1924. *Squilla oratoria*, var. *inornata*, Hale, *Rec. S. Aust. Mus.* II, pp. 495, 496.
1926. *Squilla oratoria*, var. *perpensa*, Hansen, *Siboga Exped. Rep.* XXXV, p. 11.
1927. *Squilla oratoria*, var. *perpensa*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, pp. 318, 319.

From an examination of Tate's type-specimens, preserved in the South Australian Museum, Hale came to the conclusion that the varietal form separated by Kemp, under the name of *perpensa*, from typical examples of *Squilla oratoria* could not be distinguished from Tate's species. This view does not appear to have been accepted by later workers, as Kemp's name still continues to be extensively employed for this form. Through the courtesy of Mr. H. M. Hale, Curator, South Australian Museum, I have been able to examine one of the two type-specimens from which Tate originally described this species. This specimen, though broken in two parts, is in a good state of preservation, and shows clearly all the important characters. On comparing this specimen with the types of Kemp's *perpensa* from Tuticorin, South India, preserved in the collection of the Indian Museum, no doubt is left in my mind that Kemp's form is identical with *S. inornata*, and that the name of *perpensa* employed by him should, therefore, give place to the earlier designation of Tate. The two characters emphasized by Kemp for the separation of his variety from the *forma typica*, namely, the interrupted median carina of the carapace, and the presence of a sharp, elevated carina on the dorsal aspect of the raptorial carpus, terminating abruptly before reaching the anterior margin, are very clearly seen in the specimen from South Australia that I have seen. The median carina of the carapace is wholly absent for a short distance at the base of the anterior bifurcation and the carpus of the raptorial claw has a very distinct unbroken dorsal carina, exactly as in the type-specimens of Kemp's variety, and as shown in his figure (Plate V, fig. 58). In other characters also Tate's specimen agrees closely with the Indian Museum examples.

There are, however, a few minor differences between the Australian specimen and the Indian examples. In the former the margins of the rostrum are somewhat more upturned than is usually the case, and the carinae of the carapace, especially the median, are a little more upraised. These differences may, however, be due to the Australian specimen being dry. The rostrum is also truncate anteriorly, as is the case in some of the Indian Museum types, though in a large number of these, the anterior border is more or less rounded; further it is also slightly longer and narrower than is generally the case. The shape of the anterior lateral lobe of the sixth thoracic somite appears to be somewhat variable in the variety; in some cases it is almost straight and rather sharply pointed terminally, in others it is distally curved and bluntly pointed, while in some specimens it is almost truncated. In the Australian example it is somewhat curved and bluntly pointed.

Another point worth mentioning is that in the Australian type the lateral carina of the second abdominal somite ends on each side in a small, but distinct spine. In his description of the variety *perpensa* Kemp gives the following spine-formula :—

Carinae.			Abdominal somites.
Submedian	..	..	5, 6.
Intermediate	..	..	4, 5, 6.
Lateral	..	..	3, 4, 5, 6.
Marginal	..	..	1, 2, 3, 4, 5.

An examination of the large type-series has, however, shown that though in a number of specimens the lateral carinae of the second abdominal somite do not end in spines, as described by Kemp, in others a distinct spine can be seen on each side.

It is thus seen that the few differences that have been noticed between Tate's type of *inornata* and Kemp's types of *perpensa* are of a very minor importance and do not justify the retention of Kemp's variety as distinct from Tate's form.

The Australian specimen that I have examined is a female and is approximately 65 mm. long. It was collected, along with the second syntype, in the Gulf of St. Vincent in South Australia, and is registered under number C180 in the registers of the South Australian Museum.

I refer to this variety two small female examples, 45 and 52 mm. long, collected by "Lady Fraser" at the Sandheads in 1928. One of these has both the raptorial claws missing, but the other characters mentioned by Kemp and Komai for the recognition of the variety are very clearly seen[1].

The variety has a very wide range of distribution over the Indo-Pacific area. The types are from the Gulf of St. Vincent in South Australia ; its northern range does not appear to extend beyond Formosa, while on the west it has been collected in the Persian Gulf. In the Indian waters the variety has been met with very extensively to the total exclusion of the *forma typica.*

Squilla interrupta Kemp.

1913. *Squilla interrupta,* Kemp, *Mem. Ind. Mus.* IV, pp. 72-74, pl. v, figs. 63-65.
1927. *Squilla interrupta,* Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 319.
1929. *Chloridella interrupta,* Schmitt, *Lingnan Sci. Journ.* VIII, p. 140.

As stated by Kemp, *Squilla interrupta* is one of the commonest species of *Squilla* in the Indian waters ; at the Sandheads also this species appears to be the most abundant, there being 47 specimens of it from this locality. Of these 21 are males and 26 females, and these range in size from 50 to

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[1] One large specimen sent to me by the Raffles Museum, Singapore, while agreeing with typical examples of *S. oratoria* var. *inornata* in most characters, differs from these in having the median carina of the carapace entire and uninterrupted. In this respect it resembles the *forma typica,* but in having the dorsal carina of the raptorial carpus entire, as also in all the other characters mentioned by Komai, the specimen appears to be referrable to Tate's variety.

105 mm. They agree in every respect with typical examples of the species in the Museum collection. One specimen, a male 77 mm. in size, is, however, abnormal, in so far as the basal process of the uropod of one side has a large spine arising from near its base. The spine runs outwards and somewhat backwards and bifurcates into two in its distal portion, more or less like the bifurcate process of the basal segment itself. The other uropod is quite normal, as is also the specimen itself in every other respect.

The colour of this species has been described by Schmitt, as observed by Dr. S. F. Light in living specimens. In the Indian examples, that are all preserved in spirit, the chocolate-brown and red-brown noted by Dr. Light, is not seen, but in freshly-preserved specimens the posterior margins of the last two thoracic and all the abdominal tergites are streaked with green, as are also most of the carinae on the carapace and the submedian and the intermediate carinae of the abdominal somites. The median carina of the telson and the bases of the lateral spines are also green. The patch at the proximal end of the median carina of the telson appears to be, as remarked by Komai, a very constant character of the species. The tips of the bifurcate process of the uropod are pink in comparatively fresh examples.

Squilla interrupta has a wide range of distribution over the Indo-Pacific region, having been recorded from several localities from Formosa to the Persian Gulf. Its occurence in the brackish waters at Talé Sap[1], Siam, is noteworthy.

Squilla wood-masoni Kemp.

1913. *Squilla wood-masoni*, Kemp, *Mem. Ind. Mus.* IV, pp. 74-76, pl. v, figs. 63-65.
1926. *Squilla wood-masoni*, Hansen, *Siboga Exped. Rep.* XXXV, p. 12.
1927. *Squilla wood-masoni*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 320.

I refer to this species one female specimen about 80 mm. long, collected by the "Lady Fraser" at the Sandheads in May, 1928. It agrees closely with the type-specimens of the species in the Indian Museum collection. A few minor differences are, however, seen when the specimen is compared with Kemp's description of the species. In the Sandheads example the anterior lateral process of the fifth thoracic somite, though shorter than in the allied species *S. oratoria*, with its variety *inornata* and *S. interrupta*, is proportionately longer than it is shown in Kemp's figure 63. Further, the lobe on the outer face of the longer spine of the bifurcate process of the uropod is also better developed than is shown by Kemp. In most of the examples of this species in the Museum collection, including a number of type-specimens also, the anterior process of the fifth somite and the lobe of the bifurcate process of the uropod, however, show a condition very similar to that in the specimen from the Sandheads[2]. The anterior bifurcate portion of the median carina of the carapace is, as stated by Kemp, obsolete in this

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[1] Kemp, *Mem. As. Soc. Bengal* VI, p. 297 (1918).

[2] Three examples of this species from Singapore, that I have examined for the Raffles Museum, also differ from Kemp's description and figures in these particulars.

species, though in some cases traces of it are observable, and in almost all the specimens examined there is a narrow and fairly deep depression between the anterior limbs.

The single female specimen collected by the Siboga Expedition and referred by Hansen, with some reservation, to the present species shows a close resemblance to the Sandheads example, as also to a large number of other specimens in the Museum collection, and there does not appear to be any doubt about its specific identity. In one respect, however, the Siboga example differs from the Indian specimens; a small, but quite distinct, median point on the anterior margin of the ophthalmic somite is present in all the Indian examples that I have seen, whereas in the specimen examined by Hansen it is said to be absent.

Squilla wood-masoni closely resembles *S. oratoria*, with its variety *inornata*, and *S. interrupta*, but can be easily distinguished from these with the help of the characters mentioned by Kemp, especially by its shorter and broader carapace.

Squilla wood-masoni is a fairly common species in the Indian waters. According to Kemp it is distributed " over an area ranging from Hong-kong and the Australian Coast to the Persian Gulf, Aden and Zanzibar." Komai has recorded the species from Formosa also.

Squilla raphidea Fabricius.

1913. *Squilla raphidea*, Kemp, *Mem. Ind. Mus.* IV, pp. 88-92, pl. vii, fig. 77.
1927. *Squilla raphidea*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 323.

I refer to this common Indo-Pacific species 19 examples collected at the Sandheads. Of these only 2 are males and 17 females; in size they range from 106 to 280 mm.

Squilla raphidea has been recorded from a large number of localities from Japan to the east coast of Africa. It occurs very commonly in the Indian coastal waters.

Komai has described the colour of fresh specimens.

Squilla annandalei Kemp.

1913. *Squilla annandalei*, Kemp, *Mem. Ind. Mus.* IV, pp. 92, 93, pl. vii, figs. 78, 79.
1921. *Squilla annandalei*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 307.

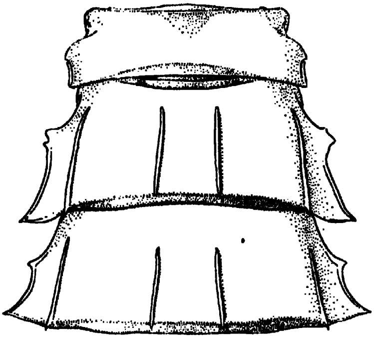
Squilla annandalei appears to be a somewhat rare species. Kemp recorded four examples of it from the Gulf of Martaban, Sunier[1] two from the Java Sea, and Kemp and I one from the Mergui Archipelago. All these specimens were obtained at depths varying from 30 to 67 fathoms. I refer to this species one more example from the Sandheads, collected at a depth not exceeding 20 fathoms.

C 1656/1	Sandheads, mouth of the River Hughli.	" Fraser ", 22. iii. 1923.	1♀, 96 mm.

The specimen from the Sandheads agrees in all particulars with Kemp's account of the species, as also with named examples in the

[1] Sunier, *Contrib. Faune Indes Neerland*, IV, p. 70 (1918).

Museum collection. The anterior lateral process of the sixth thoracic somite is, as mentioned by Kemp, prominent and acute in this species, but there appears to be a tendency for this to become secondarily bilobed. In two of the specimens from the Gulf of Martaban in the Museum collection there are slight indications of this bilobing visible; on one side of each of these specimens the anterior lateral process of the sixth somite has a minute projection on its anterior face, while on the other side of one of these, two small lobes can be somewhat indistinctly made



TEXT-FIG. 2.—*Squilla annandalei* Kemp.
Dorsal view of fifth, sixth and seventh thoracic somites of specimen from Sandheads.

out. In the example from the Sandheads there are two distinct lobes seen on the left side, while on the right also a minute lobe can be made out on the anterior edge of the lateral process.

The colour of the species has been briefly described by Kemp. The posterior borders of the last three thoracic and all the abdominal somites are prominently edged with dark brown. This is clearly seen in the type-specimen, as also in one or two other examples in the collection. The dark transverse patch, sometimes broken into four separate spots, on the second abdominal somite, and the two black spots near the proximal edge of the telson are very characteristic of the species.

Squilla annandalei is known from the Java Sea, Mergui Archipelago, Gulf of Martaban, and mouth of the Hughli River.

Lysiosquilla maculata (Fabricius).

1913. *Lysiosquilla maculata*, Kemp, *Mem. Ind. Mus.* IV, pp. 111-116, pl. viii, figs. 86-91.
1926. *Lysiosquilla maculata*, Hansen, *Siboga Exped. Rep.* XXXV, p. 18.
1927. *Lysiosquilla maculata*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 330.
1932. *Lysiosquilla maculata*, Bigelow[1], *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 169-173.

I refer to this species two male examples from the Sandheads, measuring 117 and 142 mm. in length. They agree in every detail with

[1] For references subsequent to the publication of Kemp's memoir in 1913 Bigelow's work may be consulted.

species, though in some cases traces of it are observable, and in almost all the specimens examined there is a narrow and fairly deep depression between the anterior limbs.

The single female specimen collected by the Siboga Expedition and referred by Hansen, with some reservation, to the present species shows a close resemblance to the Sandheads example, as also to a large number of other specimens in the Museum collection, and there does not appear to be any doubt about its specific identity. In one respect, however, the Siboga example differs from the Indian specimens; a small, but quite distinct, median point on the anterior margin of the ophthalmic somite is present in all the Indian examples that I have seen, whereas in the specimen examined by Hansen it is said to be absent.

Squilla wood-masoni closely resembles *S. oratoria*, with its variety *inornata*, and *S. interrupta*, but can be easily distinguished from these with the help of the characters mentioned by Kemp, especially by its shorter and broader carapace.

Squilla wood-masoni is a fairly common species in the Indian waters. According to Kemp it is distributed " over an area ranging from Hong-kong and the Australian Coast to the Persian Gulf, Aden and Zanzibar." Komai has recorded the species from Formosa also.

Squilla raphidea Fabricius.

1913. *Squilla raphidea*, Kemp, *Mem. Ind. Mus.* IV, pp. 88-92, pl. vii, fig. 77.
1927. *Squilla raphidea*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, p. 323.

I refer to this common Indo-Pacific species 19 examples collected at the Sandheads. Of these only 2 are males and 17 females; in size they range from 106 to 280 mm.

Squilla raphidea has been recorded from a large number of localities from Japan to the east coast of Africa. It occurs very commonly in the Indian coastal waters.

Komai has described the colour of fresh specimens.

Squilla annandalei Kemp.

1913. *Squilla annandalei*, Kemp, *Mem. Ind. Mus.* IV, pp. 92, 93, pl. vii, figs. 78, 79.
1921. *Squilla annandalei*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 307.

Squilla annandalei appears to be a somewhat rare species. Kemp recorded four examples of it from the Gulf of Martaban, Sunier[1] two from the Java Sea, and Kemp and I one from the Mergui Archipelago. All these specimens were obtained at depths varying from 30 to 67 fathoms. I refer to this species one more example from the Sandheads, collected at a depth not exceeding 20 fathoms.

C 1656/1	Sandheads, mouth of the River Hughli.	" Fraser ", 22. iii. 1923.	1♀, 96 mm.

The specimen from the Sandheads agrees in all particulars with Kemp's account of the species, as also with named examples in the

[1] Sunier, *Contrib. Faune Indes Neerland*, IV, p. 70 (1918).

It thus seems fairly evident that even though the shape of the rostrum alone may not afford a very satisfactory character for the separation of Kemp's variety from typical examples of *L. maculata*, the association of the shape of rostrum as seen in Kemp's type-specimen of the variety *sulcirostris* with the presence of only eight teeth on the raptorial dactylus should be sufficient to distinguish between the two. The only specimen of *L. maculata* with eight teeth on the raptorial claw so far recorded is one of the two females from Samoa mentioned by Bigelow, but in this the rostrum is of the typical kind.

The pale eye-spot in the dark band close to the anterior margin of the carapace, mentioned by Bigelow and shown in his figure 9, is present in the Sandheads specimens and the other examples in the collection of the Indian Museum. In other respects the colour of my examples agrees with Kemp's account of it.

Lysiosquilla maculata is one of the most widely distributed species of Stomatopoda. It has been recorded from a large number of widely-separated localities over the entire Indo-Pacific area, and has also been collected in one or two places in the Atlantic.

Lysiosquilla acanthocarpus Miers.

1913. *Lysiosquilla acanthocarpus*, Kemp, *Mem. Ind. Mus.* IV, pp. 120-122.
1927. *Lysiosquilla acanthocarpus*, Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, pp. 231, 232.
1930. *Lysiosquilla acanthocarpus*, Komai and Tung, *Annot. Zool. Japon.* XIII, pp. 14, 15.

One specimen of this somewhat uncommon species has been collected at the Sandheads. It agrees in almost every particular with Kemp's excellent and very detailed description of the species, as also with examples named by him and preserved in the collection of the Indian Museum.

Komai in 1927 referred two female examples to the present species. Of these, one from Formosa is said to "agree very well with Kemp's description of the species," though it had seven teeth on the raptorial dactylus, instead of six as is generally the case in the species. The other example from the Pacific coast of Honsyu shows still greater differences. The rostrum is broader than long, there are nine spines on the raptorial dactylus, the tubercle at the base of the dactylus, so characteristic of the species, is obsolete, and there are four marginal spines on one side of the telson and three on the other. From a consideration of these characters it appears almost certain that the Pacific coast specimen at least cannot be referred to Miers' species. The examples from Suruga Bay, a male and a female (Komai and Tung), are referable to the present species.

Excluding the Sandheads example, there are at present nine specimens of this species in the Museum collection; of these there are two males and seven females. In one specimen only are there five teeth on each raptorial dactylus; all the others have six on each side. The rostrum is always longer than broad, the prominence at the base of the dactylus is well marked, and the marginal teeth of the telson are quite normal in number and disposition.

The Sandheads example is a female and is registered as under :—

C 1657/1	Sandheads, mouth of the River Hughli.	"Lady Fraser", April, May. 1932.	1 ♀, 81 mm.

Lysiosquilla acanthocarpus has been recorded from Formosa, North Australia, Penang, Andaman Islands, both the coasts of Peninsular India and Trincomali in Ceylon. Komai's record of the species from the Pacific coast of Japan is, as mentioned above, somewhat doubtful.

Squilla kempi (Schmitt).

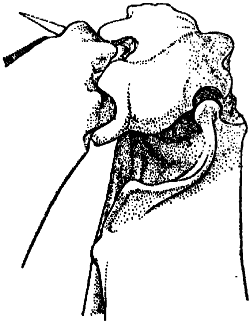
1913. *Squilla oratoria*, Kemp, *Mem. Ind. Mus.* IV, p. 69, pl. v, fig. 56 (*partim*)[1].
1927. *Squilla oratoria*, "*Southern forms*." Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.* (B) III, pp. 315, 316.
1929. *Chloridella kempi*, Schmitt, *Lingnan Sci. Journ.* VIII, pp. 135-140, pls. xvii, xviii.

Schmitt, in the paper cited above, described *Squilla kempi* as a new species from Dr. S. F. Light's collection from Southern China, basing the specific name on the manuscript name given by Dr. Light in honour of the famous carcinologist and monographer of the Indo-Pacific Stomatopoda—Dr. Stanely Kemp. The Light collection, as remarked by Schmitt, was first submitted for study to Dr. Kemp, who was at the time connected with the Indian Museum, but on account of other engagements Dr. Kemp could not complete the work before his taking over charge of the "Discovery" Expedition, and the collection was, therefore, sent on to Dr. Schmitt with all the notes, etc., that Dr. Kemp had already made on the collection. From his correspondence with Dr. Light in this connection, copies of which are on the files of the Zoological Survey of India, it appears that Kemp, in view of the differences that exist between typical specimens of *Squilla oratoria* and those of the form later described by Schmitt as *S. kempi*, had at first suggested calling the latter as a variety of the former, but on reconsideration he agreed with Dr. Light that the two were specifically distinct. Through the generosity of Dr. Light the Indian Museum possesses two fine specimens, a male and a female, of Schmitt's species, and a careful examination of these has shown that the form is undoubtedly distinct from *S. oratoria*, and the differences between the two warrant a specific distinction. Komai had also noticed these differences, but he separated examples of *S. kempi* from typical specimens of *S. oratoria* under the name of "Southern forms." Komai's description of this form agrees almost exactly with the specimens of *S. kempi* that I have examined, as also with Schmitt's description of the species, except for the fact that Komai has omitted to make a mention about the presence or absence of a spine on the outer inferior angle of the raptorial merus. A re-examination of Komai's specimens on this point, as suggested by Schmitt, would be very desirable, though it is likely that the spine would be found wanting. In the same way the two examples from Amoy, belonging to the British

[1] Only the examples from Amoy, described by Kemp, are referable to Schmitt's species.

Museum, that Kemp provisionally included in his account of *Squilla oratoria* are also most likely referable to Schmitt's species ; the correspondence referred to above indicates that Kemp, while in England in 1923, re-examined these specimens and found them to be identical with the form later designated as *S. kempi*[1].

As pointed out by Schmitt, *Squilla kempi* resembles *Squilla oratoria* in several important respects, but the table given by Komai for the separation of his "Northern" and "Southern" forms of *S. oratoria* can be very usefully employed for distinguishing the two species. I give below a somewhat amplified table for separating these rather very similar species. The characters mentioned in my table are all included in Schmitt's excellent description of the species, and have been verified by me with the help of the specimens in the Indian Museum collection. The statement made by Dr. Light regarding the anterior bifurcation of the median carina of the carapace—mentioned in Schmitt's description of the species— is not borne out by an examination of the Indian examples. The median carina is entire in both the specimens that I have seen, but in view of Dr. Light's observations, and of the fact that in one of the two Amoy specimens included in Kemp's account of *S. oratoria*, the anterior bifurcation is said to be interrupted, it is likely that there is some variation in the species in this respect. Further the carina on the raptorial carpus also appears to show a considerable range of variation. Out of the three specimens examined by Schmitt only the right carpus of the female type-specimen is said to have three sharply-



TEXT-FIG. 3.—*Squilla kempi* Schmitt.
Raptorial carpus showing the dorsal carina with three weak lobes.

marked tubercles on the dorsal carina ; in four of the six carpi examined the tubercles are weak and lobiform ; while in the remaining sixth carpus —the left one of the single male example—there is a continuous ridge, more or less like that of the variety *inornata* (=*perpensa*) of *S.*

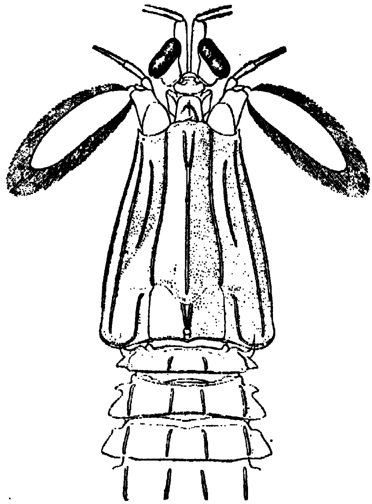
[1] Since the above went to the press, Dr. Kemp has, at my request, once again examined these specimens and compared them with Schmitt's description of the species. He has no doubt that the Amoy specimens are referable to *Squilla kempi* and that the latter is a valid species. He has also sent me a list of characters which distinguish *S. kempi* from *S. oratoria* ; most of these characters are included in the table on p. 33. I am very grateful to Dr. Kemp for the valuable help he has given me in this matter.

oratoria, but with three small thickenings or tiny tubercles on the outer side. In the two specimens seen by me also the carina of the raptorial carpus shows variation. In the male the carina is broken up into three distinct, though weak, lobes, but in the female it is a more or less continuous ridge, with very slight indications of three lobes; the ridge terminates abruptly before reaching the anterior margin. It thus appears that typically the dorsal carina of the raptorial carpus is broken up into three somewhat weak tubercles or lobes, but sometimes these are more or less obsolete and the carina is practically entire, as in the variety *inornata* of *Squilla oratoria*. It must, however, be pointed out that in typical examples of *oratoria* also the carina, as mentioned by Kemp, shows a considerable amount of variation, and that in large specimens only the tubercles are well developed.

Squilla oratoria	**Squilla kempi**
1. Dorsal surface of carapace and abdomen strongly punctate.	1. Dorsal surface of carapace and abdomen sparsely and finely punctate, smooth and shining when dry.
2. Median carina of carapace entire.	2. Median carina of carapace entire, rarely interrupted at base of anterior bifurcation.
3. Anterior spine on lateral margin of fifth thoracic somite somewhat curved, the tip pointing forward and outward; posterior spine somewhat bluntly pointed.	3. Anterior spine on lateral margin of fifth thoracic somite more strongly curved, the tip pointing forward and slightly inwards; posterior spine sharply pointed (text-fig. 4).
4. Anterior lobe on lateral margin of sixth thoracic somite only slightly shorter than posterior and more or less parallel-sided.	4. Anterior lobe on lateral margin of sixth thoracic somite much shorter than posterior, and somewhat triangular in shape.
5. Anterior lobe of seventh thoracic somite acutely produced.	5. Anterior lobe of seventh thoracic somite only a minute rounded projection.
6. Lateral process of eighth thoracic somite acutely pointed anteriorly.	6. Lateral process of eighth thoracic somite rectangular or a little obtuse anteriorly.
7. Outer inferior angle of merus of raptorial claw with a distinct spine or a sharply-pointed angle.	7. Outer inferior angle of merus of raptorial claw bluntly rounded, without an indication of a spine or a sharply-rounded angle (text-fig. 3).
8. Dorsal carina of raptorial carpus with 3-5 sharp tubercles.	8. Dorsal carina of raptorial carpus generally with 3 weak tubercles or lobes; tubercles or lobes sometimes almost obsolescent.
9. Carina on ventral surface of telson behind anal opening strongly developed.	9. Carina on ventral surface of telson behind anal opening rather feebly developed.
10. No distinctive colour markings on dorsal surface of body; first segment of exopodite of uropod uniformly light green.	10. In spirit specimens second and fifth abdominal somites with conspicuous patches of dark colour; distal part of first segment of exopodite of uropod also coloured black.

Squilla kempi occurs commonly along the coasts of Southern China, Dr. Light having collected numerous specimens of it at Hoihow, Amoy, Dodd Island Lighthouse, Chin Bay and several other localities. It has also been recorded from Foochow (Kellog, see Schmitt), Formosa, Ryûkyû, Kyûshû, Inland Sea and some other places (Komai). It is commonly taken in the company of *Squilla oratoria*, but does not extend to the northern range of this species. It lives in shallow water and prefers a muddy bottom. Dr. Light, in his correspondence with Dr. Kemp,

gives some very interesting particulars about this species. Mentioning the localities from which he collected *S. kempi*, Dr. Light says : " I have



TEXT-FIG. 4.—*Squilla kempi* Schmitt.

Dorsal view of the anterior part of the body. The lateral lobes of the fifth, sixth and seventh thoracic somites are very clearly seen.

large series of the typical form (*S. oratoria*) from the same localities and there are no signs of intergradations either in color or in the morphological characters noted. The typical form is generally lighter in color and without any striking color blotches, while the variety under description (*S. kempi*) is generally browner and has a broad dark chocolate brown band across the centre of the 2nd abdominal segment and an area of the same color marking the distal part of the inner segment of the exopodite of each uropod. It also seems to be typically larger, broader and heavier." Further on he states : " The proportional frequency of the different species of *Squilla* in a collection made from the debris from the shrimp nets[1] at Tsimei may be of interest to you. Of the 233 specimens collected 5 were *S. scorpio*, 2 were *S. faveolata* (more common in Amoy Harbour[2] ; apparently more of an open sea species), 16 were *S. interrupta* and the remaining were *S. oratoria* s. lat., of which 133 were *S. oratoria*, var. *perpensa*, 43 typica, 21 doubtful or intermediate and 13 of the variety I propose to consider *S. kempi*. The individuals of the last named form reach the largest size of any taken here as yet. They are readily separable at once from any other of the local forms by color and it seems to

[1] Schmitt has given a description of these nets, *vide* p. 129 of the paper cited above.

[2] There are in the Indian Museum three specimens of *S. faveolata* from Amoy Harbour presented by Dr. Light.

me by shape.... The posterior end of the abdomen gives the impression of being considerably broader and flatter than in the case of *S. oratoria typica* and var. *perpensa.*"

In the Indian Museum there are two specimens from Tsimei :—

C 955/1	From nets at Tsimei, China.	S. F. Light.	1 ♂, 1 ♀, 125 and 88 mm.

As in *S. oratoria* the mandibular palp is well developed and epipodites are present on the first four thoracic limbs. The corneal index in the male specimen I have seen is about 4·8, while in the other example the cornea is proportionately broader and the index is about 3·9 only.

Squilla indica Hansen.

1926. *Squilla indica,* Hansen, *Siboga Exped. Rep.* XXXV, pp. 12-14, pl. i, figs. 4*a*-4*c*.

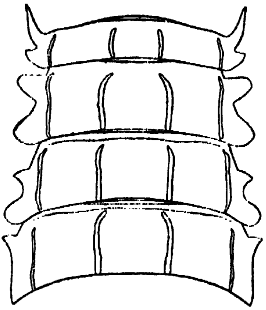
As pointed out by Hansen, *Squilla indica* belongs to the group of species in which *S. oratoria* and its allies are placed, but that it can be easily separated from the other species in this group is clear from Hansen's description of it.

One female specimen, collected by the R. I. M. S. "Investigator" in the Nicobar Islands, agrees very closely with Hansen's description of the species, and is no doubt referable to it.

The median carina of the carapace is altogether obsolete in the anterior part (considerably more so than in Kemp's *Squilla wood-masoni*). The anterior breadth of the carapace at the level of the base of the antero-lateral spines is markedly less than half the length of the carapace and rostrum, and is even less than the length of the carapace alone.

The rostrum is as described by Hansen, and is distinctly longer than its breadth at the base. No trace of the median keel is visible in my specimen.

There are seven well-developed, long and slender spines (including the terminal one) on the dactylus of the raptorial claw, but the rounded



TEXT-FIG. 5.—*Squilla indica* Hansen.
Dorsal view of the first four exposed thoracic somites.

protuberance near the base of the dactylus is hardly conspicuous. The outer margin of the dactylus is evenly rounded. The carina on the dorsal

aspect of the carpus is as described by Hansen, and the inferior margin of the merus is angular and does not carry a spine.

The lateral processes of the first three exposed thoracic somites differ considerably from those of the allied species. The anterior lateral process of the fifth somite is a narrow elongated, spine-like structure, strongly curved at the base in a forwardly direction and running more or less parallel with the long axis of the body. The posterior process of this somite is a somewhat large truncate lobe, with the anterior angle rather acute. The margin of the sixth somite has two subequal rounded lobes, the anterior pointing somewhat forwards and the posterior directed slightly backwards. The anterior lobe of the seventh somite is shorter than the posterior, is considerably narrower and is acutely pointed; the posterior lobe is broadly rounded. The 8th somite is provided with a fairly large, more or less acutely-pointed anterior lobe (text-fig. 5).

The carinae on the last three thoracic and all the abdominal somites are well developed. There are four pairs of carinae on the first five abdominal somites and three pairs on the sixth, but most of these do not end in spines. The spines on the abdominal carinae are disposed as follows:—

Carinae.	Abdominal somites.
Submedian	5, 6.
Intermediate	5[1], 6.
Lateral	5, 6.
Marginal	5.

It is thus seen that only the fifth and sixth abdominal somites bear any spines, the other somites being altogether unarmed.

The telson has a high and sharp median carina, with a slight proximal notch, and an overhanging spine at the distal end. The carina, or its posterior spine, does not extend up to the posterior margin of the telson. The marginal teeth are well developed, but on one side the submedian and the intermediate are broken. The marginal denticles are, as observed by Hansen, acutely pointed and somewhat spine-like. On the unbroken side of the telson there are six submedian denticles, of which the proximal five have acute tips—in one or two even bifid; the sixth is very much larger than the others and is broadly rounded. There are eight sharply-pointed intermediate denticles, and one large lobe-like process on the inner side of the intermediate tooth. The single lateral denticle is also acutely pointed. The ventral surface of the telson is smooth.

The peduncular segment of the outer uropod is provided with a single spine near its articulation with the exopodite, while the outer margin of the basal segment of the exopod has seven, somewhat flattened and curved movable spines, the last of which is very much larger than the rest and overhangs the basal part of the terminal segment. The inner spine of the bifurcate process is much longer than the outer spine, and has its inner margin serrate. The lobe on the outer margin of this spine is, as described by Hansen, uncommonly large, and the margin anterior to the lobe is deeply concave.

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[1] The spine is clearly seen only on one side of this segment.

The colour of the single specimen I have seen is not characteristic, but on the posterior half of the carapace there is a dark patch in the median line. The posterior margins of the last two thoracic and all the abdominal somites are narrowly edged in dark-brown, and there are traces of a patch of the same colour on the dorsal surface of the second abdominal somite. The distal segment of the exopod of the uropod is dusky, and the distal half of the endopod is also similarly bordered.

In the Indian Museum example the mandibular palp is altogether absent, and epipodites are present on the first two thoracic limbs only; the epipodite at the base of the raptorial claw is of about the same size as that of the first leg.

The specimen in my collection has yielded the following measurements :—

Total length of body	41 mm.
Length of carapace (excluding rostrum)	9·7 mm.
Breadth of carapace at antero-lateral angles	4·0 mm.
Length of rostrum	1·8 mm.
Breadth of rostrum	1·3 mm.
Breadth of cornea	2·5 mm.
Corneal index	3·88
Breadth of telson	7·2 mm.
Median length of telson (excluding spines)	6·4 mm.

The Indian example is registered as under :—

C 1658/1	Octavia Bay, Nancoury Harbour, Nicobars ; 13 fathoms.	Marine Survey, 22, 23 Nov., 1922.	1 ♀, 41 mm.

Besides the specimen now recorded, the species is known from two examples only, a male and a female, collected by the Siboga Expedition, one in the Celebes Sea and the other in the Buton Straits. Of the two specimens, the male shows some slight differences from the female, which is considered as the type. The Indian example agrees closely with the Siboga female.

Though *Squilla indica* has a superficial similarity with the species in the *nepa* group of the genus, it differs from all the members of this group in a number of very well-marked characters. The total suppression of the mandibular palp, the presence of epipodites on two legs only, and the possession of seven (or eight) teeth on the raptorial dactylus clearly separate this species from all its allies; while the longer and more sharply-pointed rostrum, the different shape of the lateral processes of the thoracic somites and the uncommonly large lobe on the outer face of the longer spine of the bifurcate process of the uropod are all characters that are not shared by any other species in this group. Besides these characters the absence of spines at the posterior extremities of the dorsal carinae on the first four abdominal somites is noteworthy. Within the group, *Squilla indica* shows some resemblance to *S. wood-masoni* Kemp in the, more or less, total suppression of the anterior part of the median carina of the carapace, and the lateral processes of the free thoracic somites show a slight similarity to those of *S. interrupta* Kemp, but the differences enumerated above far outweigh these isolated points of resemblance. *S. indica* thus appears to be a species of very uncertain affinities. The total suppression of the mandibular palp, and the great

reduction in the number of epipodites on the thoracic legs are very remarkable characters of this species, in so far as these characters are not found in any other species of the *nepa* group.

The only Indo-Pacific species known[1] to me that have epipodites present on the first two legs only are *S. gibba* Nobili, *S. supplex* Wood-Mason and *S. scorpio* Latreille (with its variety *immaculata* Kemp), and all these except Wood-Mason's species are further characterized by the total absence of the mandibular palp. *S. indica* also, as stated above, shows these characters, but there does not appear to be any close similarity or affinity between it and the species mentioned above[2].

The facts stated above lend support to the opinion that Kemp and I[3] expressed in 1921 regarding a reduction in the number of epipodites in the genus *Squilla*. From an examination of the large collections preserved in the Indian Museum we were led to remark "that a reduction in the number of epipods has taken place in the genus *Squilla* on several different occasions and that the character, though possessing a definite specific value, cannot be used as a guide to the affinities of the different forms. In this it resembles the mandibular palp, which appears and disappears throughout the genus, apparently without any regard to the affinities of the species concerned."

Squilla lirata Kemp and Chopra.

1921. *Squilla lirata*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, pp. 303-307.

Two fine female specimens of this apparently rare species are in the present collection. They were collected at Singapore by Mr. M. W. F. Tweedie, and have been presented to the Indian Museum by the Raffles Museum, Singapore. The species was described in 1921 from two examples only from Singapore, and does not appear to have been recorded so far from any other locality. The present specimens agree closely with the published description, as also with the type-specimens preserved in the Indian Museum.

The two specimens examined in 1921 differed from one another in the nature of the anterior bifurcation of the median carina of the carapace. In one example the whole of the carina from the mid-dorsal pit to the anterior margin of the carapace was bifurcated, but it was distinctly interrupted at the point of bifurcation; in the other specimen the carina was entire, and was bifurcated for little more than half the distance between the dorsal pit and the anterior margin. In the two specimens now examined the carina is entire, there being no interruption at the point where it divides, but the bifurcation extends for the whole distance from the mid-dorsal pit to the anterior end of the carapace.

Another point worth mentioning is that in the specimens described in 1921 the first two abdominal somites were found to have only three

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[1] Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 298 (1921).

[2] Bigelow has recently described another species, *S. mauiana*, sp. nov. in which only two pairs of epipodites are present and the mandibular palp is also absent. This species was taken in the Hawaiian group of islands in the Pacific, and does not appear to show any marked similarity or affinity to *S. indica*. For a description of this species see Bigelow, *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 177-182 (1932).

[3] Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 299 (1921).

carinae between the submedians, thus differing from examples of *S. multicarinata* White, in which there are five such carinae. In the specimens now before me the position is slightly different. On the first somite there are three well-marked carinae between the submedians, as described before, but on either side of the middle one of these three, there is a short low carina on the posterior half of the segment. These low carinae are better developed on the second somite, where they extend on about the three-fourths of the dorsal surface, and though lower than the principal carinae are still quite sharp and are distinctly seen.

Apart from these minor differences the specimens agree in every respect with the types.

C 1659/1	Siglap, Singapore.	M. W. F. Tweedie, June, 1933.	2 ♀♀, 73 and 74 mm.

The species is so far known from Singapore only.

Pseudosquilla ciliata (Fabricius).

1913. *Pseudosquilla ciliata*, Kemp, *Mem. Ind. Mus.* IV, pp. 96-100.
1932. *Pseudosquilla ciliata*, Bigelow, *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 152-160.

One specimen is referred to this species :—

C 1660/1	Southern Point, Outram Island, Andamans.	Marine Survey, 5.ii.1924.	1 ♂, 22 mm.

The specimen, though small and with a carapace length (excluding the rostrum) of only 4·2 mm., shows practically all the characters of the adult. The submedian carinae on the telson are, however, absent, and the copulatory organs appear to be somewhat weakly developed. The teeth on the raptorial dactylus are quite large. The postero-lateral angle of the fourth abdominal somite bears a short, but distinct spine. In all other characters the specimen agrees exactly with Kemp's description of the species. A small but distinct spine, as mentioned by Bigelow, can be seen on the distal end of the raptorial propodus. The presence of this spine has not been noticed by Kemp, but it is present in all the specimens in the Indian Museum collection.

The species has a wide range of distribution in the Indo-Pacific and the Atlantic Oceans.

Pseudosquilla oculata (Brullé).

1913. *Pseudosquilla oculata*, Kemp, *Mem. Ind. Mus.* IV, pp. 102, 103.
1921. *Pseudosquilla oculata*, Edmondson, *Occ. Papers Bishop Mus.* VII, pp. 290-292.
1925. *Pseudosquilla oculata*, Edmondson, *Bull. Bishop Mus.* XXVII, pp. 59, 60.
1932. *Pseudosquilla oculata*, Bigelow, *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 165-168.

One specimen from the Maldive group of islands agrees closely with the published descriptions of the species, as also with the small and somewhat broken example from the Society Island in the Museum collection.

C 1661/1	Reef on the north side of Fuladu Island, Goifurfehendu Atoll, Maldives.	Marine Survey, 10.xii.1923.	1 ♂, 42 mm.

The specimen has a carapace length of 10 mm.

P. oculata, like the preceding species, is also known to live both in the Atlantic and the Indo-Pacific Oceans. In the latter its range extends from the Society Islands, Hawaii and Samoa to Mauritius on the western side.

Gonodactylus glabrous Brooks.

1913. *Gonodactylus glabrous*, Kemp, *Mem. Ind. Mus.* IV, pp. 167-169, pl. ix, fig. 113.

1932. *Gonodactylus glabrous*, Bigelow[1], *Bull. Mus. Comp. Zool. Harvard* LXXII, pp. 127-135.

Bigelow, in the paper cited above, gives a very detailed description of the species, mentioning a number of points that had been overlooked by most of the previous workers. The specimens of this species mentioned by Kemp, as also those now examined by me, agree with Bigelow's account in almost every particular, though in a variable species like the present, there are bound to be considerable differences of a minor importance between specimens from different localities. The sexual dimorphism, pointed out by Bigelow, is very clearly seen in the large number of specimens of both sexes that I have examined. In young examples the sculpturing of the sixth abdominal somite and of the telson is similar in both sexes, but in specimens of about 40 mm. and over, one can almost invariably separate the two sexes by examining the keels on the telson and on the last abdominal somite. Another point that I have noticed is that whereas in young examples and in most of the female specimens examined all the six keels on the last abdominal somite and the three central keels on the telson end in spines, in large males generally these spines are missing. In the latter case in several specimens a careful examination reveals signs of the breaking off of the spines, but it is noteworthy that this breaking off seems to take place more often in the males than in the females. I have examined 68 large specimens from our collection with special reference to the presence or absence of these spines, and they have yielded the following results :—

Out of 49 females examined
- 30 had spines well developed,
- 13 had spines present on some keels, broken or missing on others, and
- 6 had no spines.

Out of 19 males examined
- 2 had spines well developed,
- 4 had spines present on some keels, broken or missing on others, and
- 13 had no spines.

The uropods in *G. glabrous* present certain peculiar features, which have been fully described by Bigelow. The specimens examined by me closely agree with Bigelow's description. The tip of the dactylus of the raptorial claw is also as described and figured by Bigelow, though a breaking off of the tip is noticeable in several instances.

[1] This paper contains a complete synonymy since the publication of Kemp's monograph.

The colour in comparatively fresh specimens is as described by Kemp. The minute spots on the telson, in addition to those on the sixth somite, that Bigelow has mentioned, are also clearly seen in a large number of the Indian examples.

Gonodactylus glabrous has a very wide range of distribution over the Indo-Pacific area. Kemp and Bigelow have given a number of localities from which the species has been recorded. It is known to occur in the Mediterranean Sea also. The additional specimens now seen by me are mostly from localities already mentioned by Kemp.

One female specimen from the Andamans is abnormal in so far as the median carina of the telson is much shorter than the others, the first submedian carinae are arched and converging posteriorly approximate toward one another in the median line, so as to partly encircle the median carina. The bifurcate process of the uropod of one side in this example is also abnormal, as the spines are very short, and the lobe or tooth at the base of the outer spine is missing. This is perhaps a result of regeneration. The process of the other side is quite normal.

Gonodactylus pulchellus Miers.

1913. *Gonodactylus pulchellus*, Kemp, *Mem. Ind. Mus.* IV, pp. 177-179, pl. x, figs. 117, 118.
1921. *Gonodactylus pulchellus*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 311.
1921. *Gonodactylus pulchellus*, Tattersall, *Journ. Linn. Soc.* (Zool.) XXXIV; pp. 364, 365.
1926. *Gonodactylus pulchellus*, Hansen, *Siboga Exped. Rep.* XXXV, p. 38.
1929. *Gonodactylus pulchellus*, Hale, *Trans. Roy. Soc. S. Australia* LIII, p. 34.

With the help of the table given by Kemp [1] in 1915, *G. pulchellus* can be easily distinguished from *G. trispinosus*, *G. nefandus* and other allied species, with which it has a very close resemblance. I refer to this species a single specimen collected in the Nicobars in 1922. Even after immersion in spirit during all these years the dark patches of colour mentioned by Kemp in 1913 can be clearly made out.

C 1662/1	East coast of Camorta Island, Nicobars.	Marine Survey, 23.x.1922.	1♀, 34 mm.

The species is known from a number of localities in the Indo-Pacific region, from North Australia to East Africa.

Gonodactylus nefandus Kemp.

1913. *Gonodactylus nefandus*, Kemp, *Mem. Ind. Mus.* IV, pp. 179, 180, pl. x, figs. 119, 120.
1921. *Gonodactylus nefandus*, Kemp and Chopra, *Rec. Ind. Mus.* XXII, p. 311.
1926. *Gonodactylus nefandus*, Hansen, *Siboga Exped. Rep.* XXXV, p. 32.

I refer to this species two specimens that agree closely with Kemp's type-specimens in the Indian Museum.

C 1663/1	Nancoury Harbour, Nicobars: 19-30 fathoms.	Marine Survey, 19.xii.1922.	1♀, 33 mm.
C 1664/1	Ross Channel, Port Blair, Andaman Islands: 2-9 fathoms.	S. W. Kemp, March, 1921.	1♀, 28 mm.

[1] Kemp, *Philippine Journ. Sci.* X, p. 185 (1915).

G. nefandus is known to occur commonly in the Andamans; it has also been recorded from the Arakan coast, Malacca Straits, the Philippines (Kemp and Chopra), and a number of localities in the Indian Archipelago (Hansen).

As stated by Kemp, the spirit specimens of *Gonodactylus nefandus* have no characteristic colouration, there being only a dark and inconspicuous mottling on the carapace and abdomen. Fresh examples, however, appear to have a very striking colour. Dr. Kemp has described in his Station Book the colour of the specimen that he collected in the Ross Channel, Andamans (C 1664/1) as follows:—

"Carapace and abdomen dorsally mottled with brown and red on a pale ground, the brown mottling tending to form two transverse bars on carapace. Last somite and telson dull green. A white spot at base of central rostral spine. Antennular flagella red. Thoracic appendages bright red terminally, except raptorial claw, which is mottled at base, with white terminal segments. Uropods red at base, verging to sulphur yellow or orange yellow distally."

No trace of this colouring can now be seen on this specimen, only an inconspicuous mottling, chiefly on the abdominal somites, being left after long preservation in spirit. On the first abdominal somite a short and broad transverse band can be seen in this example, as also in a number of other specimens.

Gonodactylus glaber [1] (Lenz).

1913. *Gonodactylus glaber*, Kemp, *Mem. Ind. Mus.* IV, pp. 182, 183, pl. x, fig. 121.

1915. *Gonodactylus glaber*, Kemp, *Philippine Journ. Sci.* X, p. 186.

I refer to this rather rare species two specimens collected by the R. I. M. S. "Investigator" in the Nicobars. These agree closely with Kemp's excellent and detailed description of the species, as also with named examples in the Museum collection. The differences noticed by Kemp between his smaller and larger examples are seen in my specimens also. In the smaller example the antero-lateral borders of the carapace are less acute, the eye-stalks are proportionately longer, and the feeble corrugations on the margins of the lateral lobes on the dorsal surface of the telson, that Kemp noticed in the larger example examined by him, cannot be seen.

The greatly reduced inner spine of the bifurcate process of the uropod is very characteristic of this species. The peduncular segment of the uropod terminates in a large dorsal spine, that overhangs the proximal part of the basal segment; the latter also has a small spine on its outer distal angle. Further, the bosses on the telson have a very characteristic appearance, as also the notch near the posterior end of the outer margin of the raptorial dactylus. The inner edge of the dactylus is minutely serrate.

[1] Tattersall's *Gonodactylus glaber* [*Journ. Linn. Soc.* (Zool.) XXXIV, p. 362 (1921)] is not included in this synonymy; it is really *G. glabrous* (Brooks).

C 1665/1	Camorta Island (west of Jetty), Nicobars.	Marine Survey, 13.xii.1921.	1 ♂, 27 mm.
C 1666/1	Small Coral and Rock Reef on west side of Camorta, north of entrance to Expedition Harbour, Nicobars.	Marine Survey, 3.iii.1922.	1 ♀, 18 mm.

The following measurements are taken from the two Nicobar specimens, and the large female examined by Kemp:—

	C 1665/1	C 1666/1	2690/7
Total length of body	27·0	18·0	26·0
Length of carapace and rostrum ..	8·3	5·0	7·7
Length of carapace	6·2	3·5	5·6
Breadth of carapace	4·5	3·0	4·2
Length of eye-stalk	2·4	1·9	2·3
Length of telson	4·1	2·4	4·0
Greatest breadth of telson	5·0	3·0	4·6

The smaller specimen from the Nicobars is more or less uniformly pale in colour, but the other example has brownish chromatophores scattered all over its surface, with a tendency, as mentioned by Kemp, to form bands or patches on the posterior part of the carapace, on the sixth and seventh thoracic, and on the first, fourth and fifth abdominal somites.

The species has previously been recorded from the Andamans, Ceylon and Zanzibar. Kemp recorded it from the Philippines also, but the specimens from that locality differed so much from the Indian Museum examples that he had previously examined, that he had some doubts regarding the identity of the Philippine specimens.

A STUDY OF THE FAUNA OF THE SALT LAKES, CALCUTTA.

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I. Introduction and general account of the area.

The study of the fauna of the Salt Lakes and the Deltaic region of the Ganges has from time to time attracted the attention of zoologists in Calcutta, and sixty-four years ago Stoliczka (1869) gave an account of certain researches that he had made during the previous year or two. No systematic study of this region was, however, undertaken till Annandale in 1907 commenced his studies of the "Fauna of Brackish Ponds at Port Canning, Lower Bengal" which were published in the *Records of the Indian Museum* in the next two years.

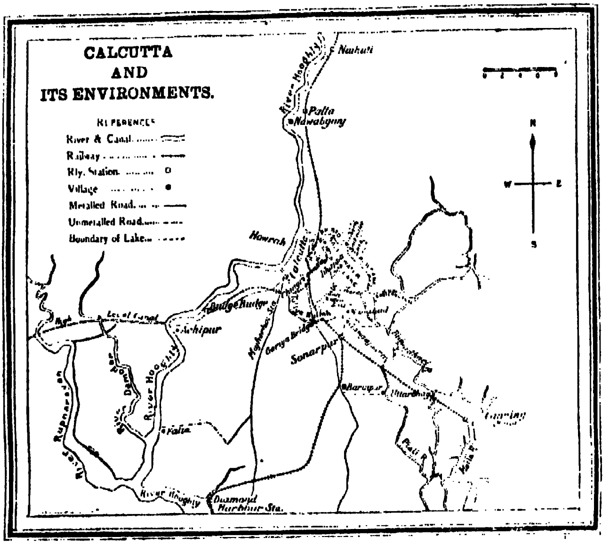
In 1926 the Zoological Survey of India established a camp, on the Kristopur Canal at the north end of the Salt Lakes, for a short period for the purpose of investigating the fauna of this area and the work was repeated in 1928.

During the past few months, owing very largely to the great curtailment in the field activities of the Survey rendered necessary by the drastic retrenchment that has been imposed on the Survey by the Government as part of their economy campaign, advantage has been taken of the close proximity of these Salt Lakes to our Headquarters in the Indian Museum to study some of the problems presented by the fauna of this area.

The Geography of the Area.

The Salt Lakes and their associated canal system are bounded on the west by the Hooghly River and are in direct communication with it by means of the Chitpore canal that leaves the Hooghly about two miles above Howrah Bridge. This canal after a course of about a mile bifurcates into two, one branch running towards the south for about two miles before it turns east past Chingrighatta and runs to Dhappa Lock; the other branch runs first east and then south-east for about a mile and then again bifurcates, the main line of the canal being continued towards the south-east to meet the Chingrighatta canal just north of Dhappa Lock; the second branch is termed the Kristopur canal and runs at first towards the north-east, but after a course of about two miles bends round and runs in a south-easterly direction for about six miles, finally turning southwards and entering the Bamonghatta canal at right angles about a mile east of Bamonghatta Lock. Dhappa Lock and Bamonghatta Lock are connected by the Central Lake channel, into which the sewage and storm-water outflow from Calcutta is poured, and this channel continues past Bamonghatta Lock to join the Bidyadhari River, that at Port Canning becomes continuous with the Matla River. Running roughly from east to west across the southern side of the Salt Lake area is Tolly's Nullah that connects the Hooghly and

Bidyadhari rivers, leaving the former about two miles below Howrah Bridge and entering the latter about four miles below Bamonghatta



TEXT-FIG. 1.—Plan of Calcutta and its environment showing the localities in which collections were made.

Lock. About three miles below the entrance of Tolly's Nullah into the Bidyadhari River a branch from the latter takes off and runs south; this branch is known as the Piali River or *Piali naddi*. Alongside most of the canals and separated from them by banks of varying height, occasionally perforated by sluice-gates, are wide expanses of water forming the Lakes proper and connected with these lakes are numerous smaller pools and creeks that at some time of the year are directly connected with the rest of the expanse of water or with the canals but that during the dry season become isolated and, finally, in the majority of instances completely dry up. The level of the water in the canals is carefully maintained by means of the locks in order that they may serve as highways for water-borne traffic. To the south of the canal system lies a wide expanse of low-lying country that during the rains is flooded with water that is slightly brackish, and this area is for the most part utilised for the growing of a particular variety of rice. As these areas dry up during the hot season the surface mud gradually hardens and becomes covered with a fine white salt deposit; and eventually it cracks into numerous separate blocks.

For several years past there has been a steady change in the conditions existing in and the general character of some of the rivers in Lower Bengal, and these changes have had a profound effect on the Salt Lakes and the associated streams and thus indirectly on the general character

of the fauna of certain areas. For our knowledge of the river changes we are indebted largely to Mr. A. N. Banerjee (1931), the River Surveyor to the Corporation of Calcutta, who has recently compiled an account of these changes. The chief changes, with which we are concerned in our study of the Salt Lakes and their fauna, are those that affect the rivers of the Matla Series, especially those of the Central Lake Channel and the Bidyadhari River, and to a less extent those that affect the Piali and Matla Rivers on the south and south-east and the Hooghly River on the west.

The Bidyadhari River "is fed by tides of two important rivers, *viz.*, the Piali and the Matla, the former joining the Bidyadhari about five miles below Shamookpota, and the latter, which may be called the outfall of the Bidyadhari, below Port Canning" (Banerjee, p. 7). The upper reaches of the Bidyadhari river commence at Dhappa Lock, that at one time formed the connection between the Salt Lake Canal system and the Central Lake Channel. Regarding the changes that have taken place in the past in this region Banerjee gives a series of figures of the range of the tide at Dhappa in the dry season, commencing as far back as 1830; I have tabulated these figures below:--

Year.	Range of Tide.	High water.	Low water.
1830	2·53 ft.	1·50 (average)	—1·25 (minimum).
1865	4·67 ,,	4·90 ,,	—4·30 ,,
1881 *	11·0 ,,	7·40 (maximum)	—3·60 ,,
1901	12·58 ,,	8·75 ,,	—3·83 ,,
1920	8·34 ,,	9·17 ,,	0·83 ,,

* In this year Dhappa Lock was constructed.

As the above figures clearly show, there was a steady increase in the amplitude of the tide up to 1901, but shortly after this date there was a decrease, that was due in the main to the rise in the height of low water. Banerjee (p. 8) goes on to point out that "the present-day condition of the tide is totally different. The tidal impulse is steadily receding off the upper reaches of the Bidyadhari and during neap tides the tidal impulse does not even reach up to Bamonghatta now-a-days." He further states that "the Bidyadhari generally carries fine sand and as such its section, according to some authorities should be narrow and deep and should approach more closely the section of those carrying clear water. The river lost this characteristic in about the year 1904". These changes are attributed to the silting up of the rivers and canals, and an attempt was made to counteract the gradual silting up of the river and especially of the upper reaches and the Central lake channel by dredging, but it was found that the process of silting was so rapid that the dredger was unable to keep pace with it and the attempt was given up. The final effect of the silting is very clearly seen in its effect on navigation. "The Bidyadhari formed a part of the inner and outer boat routes for a long time. Although the first reach of the Central Lake Channel and the Bidyadhari between Dhappa and Shamookpota was not navigable by boats of heavy drafts, yet boats of all

drafts could ply the Bidyadhari at high water upto the year 1915. Now-a-days only boats of 6" to one foot drafts can come up to the Dhappa Lock and that only during high spring tides of monsoons" (*loc. cit.*, p. 11). Since this was written an earth 'bund' has been constructed across the channel just to the south of Dhappa Lock, so that this is now useless and is rapidly silting up.

A study of both the Piali River and the Matla River indicates that here too we can trace the slow progress of deterioration. Banerjee (*loc. cit.*, p. 14) remarks "very little is known about the past history of the Piali, but there is no doubt about the fact that the river is deteriorating and that several shoals have formed, which were not in existence before. The rise of high and low water lines, though slow, is steady. The river presents a flat "U" section almost throughout its length and the bed consists of fine sands with occasional hard lumps of blue clay, the typical soil of the Sundarbans". One of the causes of this deterioration is said to be the artificial interference caused by the construction of the Piali Bridge: "the choking effect of this bridge has been very clearly demonstrated by the fact that there is frequently an afflux of more than 14 inches within a length of 1,000 feet near the bridge, and the scouring depression below the bridge is over 50 feet at low water against 5 to 10 feet at 1,500 feet up or down the bridge". Banerjee concludes that "The river being embanked on both sides has no available natural spill area for it, and, therefore, depends for its conservancy partly on its own reservoir capacity and partly on the Bidyadhari, which being situated at its head-end provides a good spill area for it. It is, therefore, very probable that the upper portion of the Piali river will die as soon as the Bidyadhari is dead" (*loc. cit.*, p. 13).

The Matla River is a tidal creek that runs up from the sea as far as Port Canning and "now-a-days it is no longer a river mouth and is mainly kept open by the ebb and flow of the tides. The Central Lake Channel and the Bidyadhari are practically dependent for their conservancy on the tides of the Matla and Piali rivers" (*loc. cit.*, p. 15). The first survey of the Matla river was made in 1839 and since then it has been resurveyed in 1855 and in 1862-63; up to this date there appears to have been little or no change, but still more recently in 1913 sections taken in the vicinity of Port Canning show that deterioration has set in, the tidal range has increased from 12 feet to about 21 feet within the last 60 years and the Government embankments are now 8 feet high against "slight embankments" on the banks of the Matla in 1853.

On the western side of the Salt Lake area the Hooghly River is the most important water-way. Banerjee notes that, "as appears from the past history of the river, it showed signs of severe deterioration in or about the year 1880, when it was suggested to excavate a channel from the port of Calcutta to the Channel Creek, a distance of 47 miles, or, as an alternative, to improve the river Matla for the purpose of the navigation of sea-going vessels and abandon the Hooghly in favour of the former estuary for serving the port of Calcutta." The intake of the river water for the purpose of supplying filtered water to the city of

Calcutta is situated at Palta, a distance of 14 miles above Howrah Bridge and is said to be at a distance of fifteen miles above the region of salinity. At a distance of some two miles below Howrah Bridge and, therefore, close to the region of salinity, though apparently still within the area of fresh water, Tolly's Nullah takes off from the Hooghly river and runs eastwards across to the Bidyadhari river, which it enters in the vicinity of Shamookpota. It has been stated that the western part of the Nullah represents the old course of the Ganges and it is sometimes referred to as the Adi-Ganga; the canal cut by Tolly in 1775-77 connected two natural channels and it was hoped that it would serve as a water-way for river craft between the Bidyadhari and the Hooghly, thus rendering unnecessary the long detour through the Sundarbans. Unfortunately, owing to the meeting of the tides from opposite ends of the Nullah there has been continual silting up of the channel and the construction of a sluice near Shamookpota to counteract this by regulating the flow of water has only resulted in further injury to the Bidyadhari River.

Much of this process of deterioration is probably the natural result of the formation and subsequent sea-ward extension of the deltaic area at the mouths of the Ganges and Brahmaputra Rivers, but there are certain subsidiary causes that have been operative in the particular area under discussion. One of these causes is the construction of various engineering works, such as bridges, canals, etc., that have interfered with the free flow of water. Another cause is the deposition of silt that is carried up the rivers and streams during the flood tide and is deposited at slack water; the effect of such silting is very clearly shown by the observations on the Bidyadhari River, which are quoted by Banerjee (*loc. cit.*, Appendix 1, p. 8). " The section close to and just below Bamonghatta shows very clearly what has been going on since 1883, as given below :—

Year.	Lowest below M. S. L.	Rise.
1883	—59·60 feet	1·45 ft. per annum
1904	—29·7 ,,	
1912	—12·0 ,,	2·21 ,,

The rate of silting is, therefore, doubled since 1904. The total deposit of silt in the last 30 years amounts to 53·7 feet." The immediate cause of this deposition is ascribed, at any rate in part, to " the method of fish culture in the Salt Lakes; at the present day water is fed into and drained from these fisheries only occasionally during the year. Most of the spill channels are kept closed with cross dams, so that the water in the river is almost entirely prevented from spilling in the lakes..... If the free spill had not been cut off a vast volume of water would return on the ebb tide and would prevent the deterioration of the river advancing at so rapid a rate. Another cause is the reclamation of the Salt Lakes for paddy cultivation, which reduces the area of the spill ".

General Considerations.

The chief zoological interest in a brackish-water area such as that under consideration lies in the fact that it forms one of the main highways by which certain constituent elements of the marine fauna of the Indian Seas can encroach on and finally establish themselves in fresh water. Researches in other parts of the world have shown conclusively that this penetration of marine organisms into fresh water is steadily going on and especially so in those areas where large rivers enter the sea through a deltaic area. Among the best known regions of this type are the estuarine regions of the great Amazon River of South America and the Congo River of Africa that open into the Atlantic Ocean; the Yangtse-Kiang River of China that opens into the Pacific Ocean; and, finally, the combined estuary of the Ganges and Brahmaputra Rivers that opens through the Gangetic Delta into the Indian Ocean. It seems possible that one predisposing factor in the gradual penetration of marine forms into fresh water is to be found in the general conditions that prevail around the mouths of these large rivers in tropical or temperate areas. The continuous outflow of large quantities of fresh water into the sea, and especially into an area such as the Bay of Bengal which is surrounded by extensive coastal barriers on three sides, necessarily results in a very considerable lowering of the salinity of the surface water, especially at the head of the Bay, down to a depth of as much as 50 fathoms, while in and just after the rainy season in the vicinity of the estuary itself the salinity of the surface-water may be as low as 1020. Thus all the inhabitants of such a coastal region must at certain periods of the year be able to withstand such a drastic change in their surroundings that a further change into brackish-water such as that found in the pools at Port Canning, in which the water varies from 1020 during the hot weather period of the year to 1012 at or soon after the end of the rainy season, is more easily borne than would be the case were these animals not already to some extent acclimatised.

Another possible factor is the great increase in the available food supply that is found in the region of such estuaries. The flow of the river brings down with it great quantities of vegetable débris and detritus, that are available as a source of food, and at the same time large quantities of nutrient salts, derived from the land, are poured out into the sea and result in a very large increase in the Diatom flora, that in turn also serves as a food supply for the smaller marine organisms. In this connection it is interesting to note the account of the flora of the Salt Lakes given by Biswas (1927) and another of the algal flora of the Chilka Lake by the same author (1932). In this latter account Biswas notes that the cryptogamic flora, consisting in the main of algae, is to be found " growing luxuriantly and profusely on rocks, boulders and pebbles on the fore-shore, on the leaves and stems of submerged plants", and he further calls attention to the fact that in many instances there appears to be a very close association between certain animals and this algal flora.

Murray (1908) has pointed out that " it is a well known fact that the clayey matter which is carried to the ocean by rivers is nearly all precipitated to the bottom on contact with the salt-water, but a small

quantity of siliceous matter is apparently still retained in salt water of relatively low salinity. Diatoms and Radiolaria, the shells and skeletons of which are chiefly composed of silica, flourish in the surface waters of the ocean where there is reason to believe clayey matter is more abundant than elsewhere. ......In the tropical Indian and Pacific Oceans, where the greatest rainfall occurs and where much detrital matter is carried into the ocean from the land; and off the mouths of great rivers both in the tropics and elsewhere, there is a great development of silica-secreting organisms in the surface waters". In consequence of these natural conditions there is a very rich and varied fauna in the estuarine regions of the tropics, and as Annandale (1922) has pointed out "we find not only a fairly large fauna of brackish-water which cannot be regarded either as strictly marine or as strictly fluviatile, but also considerable number of marine types that have established themselves permanently in fresh water far above the influence of the tides". In this paper Annandale has given an extremely interesting account of the euryhaline fauna of the brackish-water or deltaic region of the Ganges and he points out that the "Deltaic tract is tidal, even in places where the water is practically fresh, and is inhabited mainly by animals of marine origin".

With regard to the majority of the various groups of the animal kingdom that are represented in the deltaic fauna there is little to add to the account that Annandale has given. Scattered throughout the Reports on the Fauna of the Chilka Lake (*Mem. Ind. Mus.*, Vol. V, 1915-24) are numerous references by various authors to the fauna of the Gangetic Delta, and Annandale and Kemp in their introduction (*loc. cit.*, p. 15) point out that in this locality "there is also a marked faunistic element that appears to have originated actually in estuaries or backwaters subject to great changes of salinity and temperature. This element is also well represented in the Gangetic Delta and in lagoons on both coasts of Peninsular India". They further add that "perhaps the most striking feature of the biology of the permanent residents in the Lake is the extraordinary power of individual adaptability to physical changes in environment that most of them possess. It seems strange to find a Rhizostomous medusa or an Oxystome crab living in lacustrine conditions, but it is even more remarkable that individuals of such forms are able to flourish at one season in fresh water and at another in salt water".

For convenience of reference I have given below such lists of species in the various animal groups that are known to occur in the Gangetic Delta as I have been able to collate.

Several species of fresh water sponges appear to have been able to accustom themselves to life in brackish-water and Annandale (1911) mentions the following as having been found in the brackish-water pools at Port Canning and in the Salt Lakes:—

Spongilla lacustris subsp. *reticulata*.
Spongilla alba var. *bengalensis*.
Spongilla crateriformis.

In addition *Spongilla carteri* is at the present day common in those parts of the Salt Lakes that lie to the north and east of the Kristopur

canal. Annandale (1922) has also recorded the presence of "the cosmopolitan parasite *Cliona vastifica*, which is not uncommon in oyster-shells in the lower part of the Delta".

Among the Coelenterata Annandale (1915, p. 69; 1922, p. 147) records the occurrence of the following forms:—

Dicyclocoryne filamentata.
Annulella gemmata.
Asenathia piscatoris.
Bimeria fluminalis.
Diadumene schillerianum.
Pelocoetes exul.
Phytocoetes gangeticus.
Campanulina ceylonensis.
Acromitus rabanchatu.
Virgularia sp.

The last species has since been identified by Abdul Hamid (1931) as *V. gracillima*. In the great majority of species the evidence indicates that they are able to withstand changes of specific gravity that have a range from 1000 to 1025·75; *Pelocoetes exul* has been taken in water having a specific gravity ranging from 1005 to 1010 and *Dicyclocoryne filamentata* in water having a specific gravity of 1015.

In the Polyzoa Annandale (1915) has recorded the occurrence of seven species from brackish-water in the Gangetic Delta, namely:—

Membranipora bengalensis.
Membranipora hippopus.
Victorella bengalensis.
Bowerbankia caudata.
Loxosomatoides colonialis.
Barentsia gracilis.
Alcyonidium mytili.

This last species was taken attached to a Sea-snake (*Enhydrina valakadien*) at Diamond Harbour on the Hooghly river.

The Annelida have been reported on by Southern (1921) and Fauvel (1932), who have dealt with the Polychaeta; and Harding (1920) and Kaburaki (1921) have described the Leeches. In the former group, seventeen species are now known to inhabit the delta, namely:—

Matla bengalensis.
Spio bengalensis.
Eteone barantollae.
Lycastis indica.
Nereis glandicincta.
Nereis chingrighattensis.
Nereis cricognatha.
Nereis cavifrons.
Dendronereis aestuarina.
Dendronereis heteropoda.
Polydora (Carazzia) kempi.
Nephthys oligobranchia.
Barantolla sculpta.

Sabellaria spinulosa var. *alcocki.*
Sabellaria pectinata.
Mastobranchus indicus.
Potamilla leptochaeta.

In the Oligochaeta the only reference that I can find to any aquatic form is to *Branchiura sowerbyi*, that was taken together with *Lycastis indica* in the Belliaghatta Canal near Calcutta.

Among the Hirudinea *Placobdella emydae* occurs in the area under review. A single Echiuroid, namely, *Thalassema branchiorhynchus*[1] has been recorded by Annandale and Kemp (1915) from the Canal System of the Salt Lakes. Von Linstow (1907) has described a Nematode, *Oncholaimus indicus*, from brackish-water in Port Canning.

In the Arthropoda examples of the King Crab, *Carcinoscorpius rotundicauda*, are to be found well up the river Hooghly and even in water that is actually fresh. In the Entomostraca Gurney (1906, 1907) has recorded the presence of the following species :-

Copepoda.

Mesocyclops (Mesocyclops) leuckarti.

Cladocera.

Ceriodaphnia rigaudi.

and Annandale has reported the presence in brackish-water tanks at Port Canning of the Cirripedes :—

Balanus amphitrite.
Balanus patellaris.
Chthamalus stellatus.

Two species of Amphipoda have been taken in the Ganges and the surrounding deltaic region, namely *Ampelisca pusilla* and *Quadrivisio bengalensis*. The presence of the former is a matter of some considerable surprise, since it was originally described from the deep waters of the Arctic seas (*vide* Chilton, 1921). Two species of Mysids have been recorded by Tattersall from the Salt Lakes and the Gangetic delta, namely, *Potamomysis assimilis* and *Mesopodopsis orientalis*.

As regards the Decapod Crustacea de Man (1908) has identified the following species from brackish-water pools at Port Canning;

Scylla serrata.
Tympanomerus stapletoni.
Pachygrapsus propinquus.
Varuna litterata.
Metaplax dentipes.
Leander sp.
Palaemon (Eupalaemon) lamarrei.
Palaemon sp.

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[1] *T. branchiorhynchus* is not a purely brackish-water species; a large number of specimens of this interesting form were collected by Dr. F. H. Gravely from the mud-flats at Chandipore, Orissa, in 1917, and a specimen without proboscis in 1919; *vide* Prashad *Rec. Ind. Mus.* XVI, p. 399 (1919). Annandale proposed the new generic name *Anelassorhynchus* for this interesting group of species of *Thalassema* (Annandale, 1922, p. 148). *Editor.*

Caradina sp.
Caradina propinqua.
Caradina nilotica var. *bengalensis.*

Kemp (1915, 1917) reports that the following species are known from brackish-water of the Gangetic Delta :—

Pachygrapsus propinquus.
Varuna litterata.
Scylla serrata.
Neptunus pelagicus.
Clibanarius padavensis.
Palaemon mirabilis.
Penaeus carinatus.
Penaeus indicus.
Penaeopsis monoceros.
Peniaepsis brevicornis.
Parapenaeopsis sculptilis.

Examples of the genera *Metaplax* and *Hymenicus* are common in the Delta. Alcock (1895-1900) has recorded the occurrence of *Hymenicus wood-masoni* and *H. inachoides* from Port Canning and *Metaplax intermedia* and *M. crenulata* from the Sundarbans and the mouth of the Ganges. In addition he records the following species from the Gangetic Delta and the mouth of the Hooghly river :—

Doclea ovis.
Doclea japonica.
Doclea gracilipes.
Doclea tetraptera.
Calappa lophos.
Matuta victor.
Matuta lunaris.
Leucosia craniolaris.
Philyra globosa.
Philyra globulosa.
Arcania septemspinosa.
Dorippe facchino.
Scylla serrata.
Charybdis (*Goniohellenus*) *ornata.*
Conchoecetes artificiosus.
Pinnoteres mactricola (from *Mactra violacea*).
Metapograpsus messor.
Byxidognathus fluviatilis.
Sesarma tetragonum.
Metasesarma rousseauxii.

To this list may be added a species of *Gelasimus*, probably *Gelasimus annulipes*, that has succeeded in establishing itself in a colony on the left bank of the Hooghly river at Diamond Harbour. Annandale (1922, p. 151) has pointed out that " the greater number of the euryhaline crabs belong to the family Grapsidae and to such genera as *Sesarma, Varuna, Grapsus* and *Ptychognathus*..... Next to the Grapsidae

in point of numbers come the Ocypodidae, most of which belong to the subfamily Scopimerinae." In this subfamily *Tympanomerus stapletoni* is very common on the banks of the Hooghly river at Calcutta.[1] Among fresh water species *Palaemon lamarrei* is common in both fresh and slightly brackish water; *Palaemon rudis* is not unknown in the vicinity of Calcutta and *P. mirabilis* also occurs in the rivers of the delta. *Leander styliferus*, *L. tenuipes* and *L. fluminicola* are all known from the area. Of these three species Annandale remarks that "*L. tenuipes* is distinguished from the others by the extreme length and tenuity of its walking legs, which are no longer capable of supporting it on the bottom, but have apparently assumed the function of tactile organs. This species and *L. styliferus* are anadromous, but do not migrate inland beyond the limits of brackish water. *L. fluminicola* on the other hand is equally at home in fresh and in brackish water and is common well above the upper extremity of the delta." *Caridina nilotica* and *Caradina propinqua* are common in the vicinity of Calcutta.

In their account of the Mollusca of the Chilka Lake, Annandale and Kemp (1916) record the presence in the Gangetic Delta of the following species:—

Nassa denegabilis.
Nassa orissaensis.
Hydrobia (*Belgrandia*) *mylaicea.*
Stenothyra blanfordiana.
Modiola undulata.
Clementia annandalei.
Cuspidaria annandalei.

Of these the first two and the fifth are known to be able to live in water the specific gravity of which may range from 1000 to 1026·5. Preston (1915) has reported on a small collection of molluscs that was made in the Salt Lake Canal system near Chingrighatta, and in addition to the species mentioned above he records the occurrence of:—

Nassa fossae.
Tiara (*Striatella*) *tuberculata* (=*Melanoides tuberculatus*).
Tiara (*Tarebia*) *lineata* (=*Melanoides lineatus*).
Iravadia princeps.
Assiminea francesiae.
Septaria crepidularia.
Septaria depressa.
Brachydontes emarginata.
Sinodia jukes-browniana.
Cyrena bengalensis.
Macoma gubernaculum.
Anatina induta.

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[1] Two other records of the family Scopomerinae from the Gangetic Delta, that have escaped the author, are *Dotillopsis brevitarsis* (de Man) and *Tympanomerus gangeticus* Kemp (*vide* Kemp, S.—*Rec. Ind. Mus.* XVI, pp. 335, 347, 1919). *Macrophthalmus teschi* Kemp was described from a specimen collected at Port Canning; the species is also known from the Arakan Coast and Mergui (*vide* Kemp, *op. cit.*, pp. 393-394). *Editor.*

Annandale and Prashad (1919) have still further increased our knowledge of the Molluscan fauna of the Delta and added the following species to the lists of those known from this region :—

Dostia cornucopia.
Dostia depressa.
Dostia platyconcha.
Littorina melanostoma.
Littorina subintermedia.
Littorina delicatula.
Stenothyra echinata.
Stenothyra soluta.
Bithinella miliacea.
Assiminea brevicula.
Assiminea beddomiana.
Melania (Mainwaringia) paludomidea.
Nassa ennurensis.
Nassa ennurensis var. *depauperata.*
Ringicula caeca.
Auricularia auris-judae.
Auricularia gangetica.
Auricularia translucens.
Stenothyra deltae.

True marine forms, such as

Pyrazus palustris,
Potamides (Telescopium) telescopium,

make their way up the Hooghly and other branches of the Ganges, and among the truly fresh water species that have been taken in the deltaic area and the Salt Lakes are the following :—

Amnicola orcula.
Melanoides tuberculatus.
Melanoides scabrus.
Melanoides lineatus.
Pila globosa.
Viviparus bengalensis.
Limnaea ovalis.
Limnaea luteola.
Indoplanorbis exustus.

As long ago as 1869 Stoliczka recorded the presence in the deltaic region of four species of *Onchidium*, namely :—

Onchidium typhae.
Onchidium pallidum.
Onchidium tigrinum.
Onchidium tenerum.

Eliot (1916) has recorded a single Nudibranch, *Cuthona annandalei.*

It must not be supposed that the whole of this fauna is to be found at any one place in the Gangetic Delta or even that such species as are found in a given area at one time will be found there on a subsequent

occasion. I have already sufficiently indicated the great changes that are continually going on in this region and these changes have a profound effect on the fauna, while seasonal changes may cause the appearance or disappearance of species in the course of a few weeks. This is particularly well exemplified in the behaviour of *Campanulina ceylonensis*, of which Annandale (1922, p. 152) writes " Every year the lock-gates of a certain canal on the outskirts of Calcutta are opened about April and water flows in from creeks of brackish water in the delta. Shortly afterwards the water having at the time a specific gravity of about 1008·5 at 15°C., becomes alive with the medusae of this Hydrozoon, while the minute Hydroid is to be found on every submerged brick or pile in the canal. Both generations remain abundant until the rainy season commences in June or July. Then the specific gravity of the water sinks rapidly. As it does so the medusae and hydroids become scarcer. They finally disappear when it falls to about 1006·0."

I give below a note that my colleague Dr. Chopra has kindly written on the general features of the Salt Lake area in which he and some other members of the Zoological Survey of India were working in 1926 and 1928.

Some Observations on the Salt-water Lakes near Calcutta.

" A small party of the Zoological Survey of India, consisting of Dr. H. Srinivasa Rao, Mr. Mohammad Sharif and myself was sent out in May, 1926, to take preliminary observations at one end of the Salt-water Lakes. A camp was established at Dakhindari at the north end of the Lakes and a preliminary survey, lasting over a fortnight, was carried out. Some further work was also done in February, 1928, by Dr. H. S. Pruthi and myself.

At the time of our visit, the Lake at the north end consisted of a vast stretch of shallow water, with a navigation canal, the Kristopur canal, running along the north and north-east. Though the canal had high embankments along both the banks and had no direct connection with the Lake, the latter was no doubt indirectly connected with some creeks of the Hooghly, or some other branch of the river, for the water in the Lake showed a distinct rise and fall with the tidal changes. It was also distinctly, though slightly, brackish in taste. [Water-samples were obtained to measure salinity, etc., and the results obtained have been published by Biswas (1932)].

The bottom of the Lake consisted of a black, soft mud, in places forming a bed of considerable thickness. The water at the time of our visit was rather shallow, the depth being nowhere greater than a foot or 18 inches. There was a thick growth of algae, especially near the edges. The shallowness of the water, coupled with the great abundance of soft ooze-like mud made the work of investigating the outlying parts of the Lake rather difficult.

The one great fact that forced itself on our notice was the great abundance of individuals of most of the species living in the Lakes. The number of species collected by our party was rather small, but most of these species were represented by countless numbers. The Lakes are rich feeding grounds and appear to be a preserve of a

comparatively few species that have succeeded in establishing themselves in its trying and changing conditions. Thus we saw the Gastropods, *Melanoides* sp., in the mud at the bottom of the Lake, and empty shells of the same scattered about on the shores everywhere in large quantities. Another Gastropod, *Stenothyra* sp., was also found in fairly large numbers in company with *Melanoides* in the bottom mud. Similarly the Grapsid crab *Varuna litterata* was extremely common in this part of the Lake, living under half-dried mud, and its holes could also be seen on the soft shores in many places. Excepting for the Portunid *Scylla serrata*, which was quite scarce at the time of our visit, *Varuna litterata* was practically the only crab collected by our party, but it occurred in amazingly large numbers. The prawn *Palaemon lamarrei* was also common and its young ones, mixed with examples of *Caridina nilotica* were often collected in the plankton. In the same way the Mysid, *Mesopodopsis orientalis* (Tattersall), was seen swimming in vast shoals and every haul of the tow-net brought up large quantities of this. Smaller shoals of another mysid, *Potamomysis assimilis*, were also seen occasionally. An actinian, *Phyocoetes gangeticus*, was collected in large numbers in localised patches opposite Kristopur.

The canal a few yards to the north of the Lake had a fauna considerably different from that of the Lake itself. Here the current is directly connected with the main channel of the river and the level of the water, which is considerably higher than that in the Lake, is controlled by locks for purposes of navigation. The bottom, at the time of our visit, consisted of a hard sticky clay, but was considerably less muddy than that of the Lake. Here the Bivalve *Modiola striatulus* was found living at the bottom in vast numbers, mixed with comparatively fewer examples of another Lamellibranch, *Cuspidaria* sp.

Very few living *Melanoides* were collected in the canal, though they were extremely abundant in the Lake a few yards away. Another Gastropod, *Nassa* sp., was met with in the canal, but in comparatively small numbers. Living in the company of these molluscs at the bottom of the canal a long-stalked actinian was dredged out in large numbers and Polychaete worms were also quite common in this habitat. A small medusa, *Campanulina ceylonensis*, was found in the canal in such large numbers that a small tow-net kept in the water for a minute or so was always brought up containing a large quantity of a jelly-like substance that was a more or less pure culture of this medusa. Though this medusa was extremely abundant in May, 1926, I do not remember having collected any individuals at the time of our second visit in February, 1928. The crab *Varuna* was common here also and was found digging holes along the banks, but *Palaemon lamarrei* did not appear to be as common in the canal as it was in the Lake. *Caridina nilotica* appeared to be the predominant form here, as also another *Palaemon*, probably undescribed so far. The Mysid *Mesopodopsis* was collected in the canal also, but in much smaller quantities."

The Salinity of the Water.

No systematic examination of the specific gravity and salinity of the water in the Salt Lakes and the associated canals and pools has been

carried out, though from time to time certain observations have been made on this subject.

Stoliczka (1869) had a sample of water from certain ponds at Port Canning analysed and the result showed a salinity of 12·87 per mille. Annandale (1907) also examined the salinity of the water of the pools during his researches on the fauna of Port Canning and he found the salinity to vary from 12·13 per mille at the end of the rainy season to 20·22-23·16 in the month of March, at which time the water of the edge of the Matla river at Port Canning possessed a salinity of 25·46. In the rainy season the water in the pools according to Stoliczka became absolutely fresh.

From time to time observations have been carried out on the salinity of the water in various parts of the Salt Lakes and the connected waterways and most of these have already been published by Biswas (1932); and these show clearly the degree of variation in the salinity that has occurred in past years. For reference I have given below the data for four different areas in the Salt Lake system:—

Area.	1928.	
	April.	July.
Paran Chaprassi's Khal	15·48	5·97
Salt Lakes proper	14·09	4·87
Bidyadhari River	13·73	5·17
Dhappa Lock	13·53	4·67

From this it is clear that the highest salinity occurs during the month of April or early May, before the first rains come to dilute the water, and that the lowest salinity occurs during or just at the close of the monsoon rains in August. One would thus expect to find that a sample of water from any given area taken in the months of December-January would show a salinity intermediate between the two extremes. I have already called attention to the manner in which the Bidyadhari and other rivers of this region are silting up and thus preventing the salt water from extending upwards into the Salt Lake system. I have data covering several years for only a single area:

Locality.	1926.	1928.	1932-33.	1933.
	May.	February.	December to February.	March.
Z. S. I. Station 2; Canal off Lansdowne Jute Mill and Dakhindari village. Salinity per mille . .	18·48	9·00	2·20	3·60

A certain amount of this difference between different years may be attributable to seasonal changes, but as the total variation is considerably greater than that shown in the table given above, and as in March the salinity should be nearing its maximum, one is, I think, justified in reaching the conclusion that the water of this region is gradually becoming more and more fresh.

Structural Modifications.

Annandale has pointed out that "in only one species (the sponge *Laxosuberites lacustris*) can structural modification be correlated with changes in the chemical composition or specific gravity of the medium in which the animal lives. In this respect adaptation is usually physiological rather than anatomical. In most species anatomical adaptations are correlated with life in very soft mud or extremely muddy water such as are found in the bed and streams of a slow flowing silt-laden river", and he draws attention to Kemp's account (1917) of the fauna of the Matlah River and the superficial resemblance exhibited by many of the animals to the fauna of the deep-sea, especially as regards colouration and the elongation of the appendages. Among the Copepoda, however, as I have shown (*vide* Sewell, 1919, p. 17), there is in one group, namely in the genus *Acartia* and especially in the sub-genus *Acartiella* a progressive elongation of the abdominal portion of the body as we pass from the marine forms, such as *Acartia southwelli*, through the brackish-water species *Acartia chilkaensis* and *Acartia* (*Acartiella*) *major* and *minor*, to the fresh-water species *Acartia* (*Acartiella*) *tortaniformis*. Again, in the change from salt to brackish water we meet with a change in the character of the 2nd antenna in the sub-genus *Acartiella*. It seems probable that both these changes are directly correlated with a diminution in the specific gravity of the medium in which these forms are living and a consequent necessity for a greater development of the surface area in proportion to the total body mass.

Although in the main actual structural modifications are not discoverable, immigration into these estuarine regions and especially into the shallow water areas of the ponds and pools of the Salt Lakes has necessitated very great and striking changes in the physiology and the general habits of many of the inhabitants. This is particularly striking in the case of some of the fish and crabs, and my colleagues Drs. S. L. Hora and B. N. Chopra will deal with this in their accounts of the different groups: suffice it to remark here that owing to the liability of these shallow waters to extreme evaporation, by which they are at first converted from a condition of saline muddy water, through that of a thick mud, to finally a dry cracked bed, below which is only a stratum of damp hard clay, many of the fish and some crabs have developed the power of breathing atmospheric air and at the same time have acquired the habit of burying themselves at some depth below the surface, where they can aestivate until the next rains once again fill the pools with water and enable them to return to a truly aquatic form of life; and associated with this adaptation are definite modifications in some of the fish in the gills and associated respiratory apparatus.

II. THE PLANKTON, WITH SPECIAL REFERENCE TO THE COPEPODA.

In the following pages I have attempted to put together the results obtained from the examination of a number of tow-nettings that have been taken in the Salt Lakes and the associated water-ways; for those in the upper reaches of the Hooghly river above Howrah Bridge I am indebted to Dr. Pruthi and his Assistants, while the great majority of samples from the Salt Lakes, the lower reaches of the Hooghly River, Tolly's Nullah, the Piali River and the pools at Uttarbhag have been taken by Dr. Hora. Dr. Hora has also estimated the salinity of most of the samples of water that have been collected recently.

List of stations.

1. Hooghly River; Station Naihati. 16 miles above Howrah Bridge. Fresh water.

Copepoda:
Diaptomus blanci Guerne and Richard.
Diaptomus cinctus Gurney.
Diaptomus indicus, sp. nov.
Pseudodiaptomus lobipes Gurney.
Acartia chilkaensis Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).
Cladocera:
Ceriodaphnia rigaudi Richard.
Moina dubia Richard.

2. Hooghly River; Station Pulta, Opposite Water-works. 11 miles above Howrah Bridge. Fresh water.

Copepoda:
Diaptomus blanci Guerne and Richard.
Diaptomus contortus Gurney.
Diaptomus strigilipes Gurney.
Diaptomus viduus Gurney.
Pseudodiaptomus lobipes Gurney.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).
Cladocera:
Diaphanosoma excisum var. *longiremis* Ekman.
Moina dubia Richard.

3. Hooghly River; Station Nawabganj. 10 miles above Howrah Bridge. Fresh water.

Copepoda:
Diaptomus blanci Guerne and Richard.
Diaptomus cinctus Gurney.
Diaptomus contortus Gurney.
Diaptomus orientalis Brady.
Diaptomus viduus Gurney.
Pseudodiaptomus lobipes Gurney.
Acartia chilkaensis Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).

Cladocera:

Diapnanosoma excisum var. *longiremis* Ekman.

4. Hooghly River; Station Howrah Bridge. Fresh water.

Copepoda:

Diaptomus blanci Guerne and Richard.
Diaptomus contortus Gurney.
Diaptomus strigilipes Gurney.
Diaptomus viduus Gurney.
Pseudodiaptomus lobipes Gurney.
Acartia chilkaensis Sewell.
Cyclopina minuta, sp. nov.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).

Cladocera:

Diaphanosoma excisum var. *longiremis* Ekman.
Moina dubia Richard.
Ceriodaphnia rigaudi Richard.

5. Hooghly River: Budge Budge; Station 1. 4. iii. 33. Midstream. Salinity 1·07 per mille.

Copepoda:

Acrocalanus inermis Sewell.
Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Acartia (*Acartiella*) *major* Sewell.

Station 2; near the shore.

Copepoda:

Acrocalanus inermis Sewell.
Pseudodiaptomus binghami Sewell.
Diaptomus contortus Gurney.
Acartia chilkaensis Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).

6. Hooghly River; Achipur; 4. iii. 33. near shore. Ebb Tide. Salinity 2·23 per mille.

Copepoda:

Acrocalanus inermis Sewell.
Acartia chilkaensis Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Labidocera gangetica, sp. nov. (=*L. euchaeta* Giesbrecht, forma *major* Sewell).
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).

7. Hooghly River; Falta; near shore, 5. iii. 1933. Ebb Tide. Salinity 5·81 per mille.

Copepoda:

Acrocalanus inermis Sewell.
Pseudodiaptomus tollingeri Sewell.
Acartia chilkaensis Sewell.

Acartia plumosa T. Scott.
Acartia (*Acartiella*) *tortaniformis* Sewell.

8. Hooghly River; Diamond Harbour. 5. iii. 33. (*a*) near shore. Last phase of Ebb Tide. Salinity 8·50 per mille. (*b*) mid stream. Tide just flooding. Salinity 7·90 per mille.

Copepoda:
Paracalanus dubia Sewell.
Acrocalanus inermis Sewell.
Pseudodiaptomus hickmani Sewell.
Pseudodiaptomus aurivillii Cleve.
Labidocera gangetica, sp. nov. (= *L. euchaeta* Giesbrecht, forma *major* Sewell).
Pontella andersoni Sewell.
Acartia chilkaensis Sewell.
Acartia plumosa T. Scott.
Acartia spinicauda Giesbrecht.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Acartia (*Acartiella*) *major* Sewell.
Oithona brevicornis Giesbrecht.

In addition the tow-netting contained a number of examples of a species of *Sagitta* and a single Rhizostomous medusa: a few larval molluscs and "Cypris" larvae were also seen.

9. Tolly's Nullah; near Magrahat Railway Station. 7. iii. 33. Salinity 0·17 per mille.

Copepoda:
Acrocalanus inermis Sewell.
Pseudodiaptomus binghami Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).
Mesocyclops (*Thermocyclops*) *rylovi* Smirnov.

10. Tolly's Nullah; below Gariya Bridge. 2. ii. 33. Salinity 1·87 per mille.

Copepoda:
Diaptomus cinctus Gurney.
Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.
Acartia (*Acartiella*) *tortaniformis* Sewell.
Mesocyclops (*Mesocyclops*) *leuckarti* (Claus).

Cladocera:
Diaphanosoma excisum var. *longiremis* Ekman.

In addition a few examples of a species of *Mysis*, *Mesopodopsis orientalis* Tattersall and the larvae of a species of mayfly, *Cloeon*, were present.

Among the Rotifera that were present were the following:—

Brachionus bakeri Ehrb.
Brachionus bakeri var. *brevispinus* Ehrb.
Brachionus rubens Ehrb.

11. Tolly's Nullah. Gangajoara. 2. ii. 33. Salinity 4·07 per mille.
Copepoda :
Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.
Acartia (Acartiella) tortaniformis Sewell.
Mesocyclops (Mesocyclops) leuckarti (Claus).

In addition examples of the Mysid, *Mesopodopsis orientalis* Tattersall, were present.

Salt Lake Canal System.

12. Chingrighatta, in Canal. Surface tow-netting 19. x. 14,
Copepoda :
Pseudodiaptomus annadalei Sewell.
Pseudodiaptomus binghami Sewell.
Pseudodiaptomus tollingeri Sewell.
Diaptomus contortus Gurney.
Acartia chilkaensis Sewell.
Acartia plumosa T. Scott.
Acartia spinicauda Giesbrecht.
Acartia (Acartiella) tortaniformis Sewell.
Oithona brevicornis Giesbrecht.
Cyclopina longifurca Sewell.
Halicyclops aequoreus (Fischer).
Halicyclops tenuispina Sewell.
Mesocyclops (Mesocyclops) leuckarti (Claus).
Mesocyclops (Thermocyclops) rylovi Smirnov.
Stenhelia longifurca, sp. nov.
Laophonte bengalensis, sp. nov.
Mesochra meridionalis Sars.
Cladocera :
Daphnia lumholtzi Sars.
Diaphanosoma excisum var. *longiremis* Ekman.
Diaphanosoma modiglianii Richard.
Moina dubia Richard.
Ceriodaphnia cornuta Sars.
Ceriodaphnia rigaudi Richard.
? *Alona quadrangularis* Müller.
Chydorus sphaericus Müller.

In addition the Mysid, *Mesopodopsis orientalis* Tattersall, was present in large numbers.

Numerous examples of the Rotifer *Brachionus urceolaris* Ehrb. were present.

The catch shows clearly that the reproductive season was in full swing ; Nauplii larvae of several kinds and immature Copepodid stages of several species were present in large numbers and in addition females of *Pseudodiaptomus* and *Cyclopina* were carrying egg sacs.

13. Salt Lake Canal System. Dhappa Lock ; Inside Lock Gates, 20. x. 30.
Copepoda :
Diaptomus contortus Gurney.
Pseudodiaptomus annandalei Sewell,

Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.
Mesocyclops (Mesocyclops) leuckarti (Claus).

Cladocera:

Diaphanosoma excisum var. *longiremis* Ekman.
Diaphanosoma modiglianii Richard.
Moina dubia Richard, in enormous numbers.

14. Salt Lake Canal System. Between Chingrighatta and Dhappa Lock. Surface tow-netting; 29. xii. 32. Salinity 1·19 per mille.

Copepoda:

Diaptomus cinctus Gurney.
Diaptomus contortus Gurney.
Mesocyclops (Mesocyclops) leuckarti (Claus).

In addition a species of Rotifer, *Brachionus pala* Ehrb., was present in enormous numbers.

15. Salt Lake Canal System. Kristopur canal at Mile I. 28. xii. 32. Salinity 2·20 per mille.

Copepoda:

Diaptomus cinctus Gurney.
Pseudodiaptomus annandalei Sewell.
Acartia chilkaensis Sewell.
Mesocyclops (Thermocyclops) rylovi Smirnov.

Cladocera:

Moina dubia Richard, in large numbers.

In addition the following Rotifera were present:—

Brachionus pala Ehrb.
Brachionus bakeri var. *latissimus* Schm.

Both species were present in large numbers. By March 20th, 1933, the Salinity had risen to 3·60 per mille.

16. Salt Lake Canal System. Kristopur Canal at Mile 4. 28. xii. 32. Salinity 2·41 per mille.

Copepoda:

Diaptomus cinctus Gurney.
Pseudodiaptomus annandalei Sewell.
Acartia chilkaensis Sewell.
Acartia (Acartiella) tortaniformis Sewell.
Mesocyclops (Thermocyclops) rylovi Smirnov.

Cladocera:

Moina dubia Richard.

In addition the same two species of Rotifera as were present at Station 15, namely *Brachionus pala* Ehrb. and *Brachionus bakeri* var. *latissimus* Schm., were again present but in fewer numbers.

17. Salt Lake Canal System. Eastern Canal, just beyond junction with Kristopur Canal. 28. xii. 32. Salinity 2·03 per mille.

Copepoda:

Pseudodiaptomus annandalei Sewell.
Pseudodiaptomus tollingeri Sewell.
Acartia chilkaensis Sewell.

Acartia (Acartiella) tortaniformis Sewell.
Mesocyclops (Thermocyclops) rylovi Smirnov.
Cladocera :
Moina dubia Richard.

18. Salt Lakes : Z. S. I. Station 1. Large pond, connected with the canal of Lansdowne Jute Mill. 16-17. ii. 28. Salinity 12·74 per mille.

Pseudodiaptomus annandalei Sewell.
Mesocyclops (Thermocyclops) rylovi Smirnov.

19. Salt Lakes : Z. S. I. Station 2. Near edge opposite Dakhindari. 16-17. ii. 28. Salinity (on 23. ii. 28.) 9·60 per mille.

Pseudodiaptomus annandalei Sewell.

20. Salt Lakes : Z. S. I. Station 3. Northern end. 23-24. ii. 1928. Salinity 23·66 per mille.

Pseudodiaptomus annandalei Sewell.
Mesocyclops (Thermocyclops) rylovi Smirnov.

21. Salt Lakes ; Z. S. I. Station 3. Northern end. 20. iii. 33. Salinity 1·474 per mille.

Copepoda :
Mesocyclops (Mesocyclops) leuckarti (Claus).
Mesocyclops (Thermocyclops) rylovi Smirnov.
Cladocera :
Moina dubia Richard.
Diaphanosoma excisum var. *longiremis* Ekman.

In addition a large number of examples of a Rotifer, *Asplanchna brightwelli* Hudson and Gosse, were present as well as a few examples of *Brachionus bakeri* Ehrb.

22. Salt Lakes ; Southern end. Naoabad. 2. ii. 33. Salinity 5·54 per mille.

Copepoda :
Pseudodiaptomus annandalei Sewell.
Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.

In addition examples of the Mysid, *Mesopodopsis orientalis* Tattersall, were present.

23. Pool on Road-side near Milestone 4 on the way from Baruipur to Uttarbhag. 8. ii. 33. Salinity 9·24 per mille. A fortnight later the salinity of the water had risen to 10·05.

Copepoda :
Pseudodiaptomus tollingeri Sewell.
Acartia chilkaensis Sewell.
Cyclopina longifurca Sewell.
Halicyclops tenuispina Sewell.
Stenhelia longifurca, sp. nov.
Ectinosoma melaniceps Boeck.
Limnocletodes secundus, sp. nov.
? *Tachidius brevicornis*.

24. Pools in a drying up "Paddy" field at Uttarbhag; 2. i. 33. Salinity 4·38 per mille.

Copepoda:

Pseudodiaptomus binghami Sewell.
Acartia chilkaensis Sewell.
Acartia (Acartiella) tortaniformis Sewell.
Oithona horai, sp. nov.
Cyclopina longifurca Sewell.
Halicyclops tenuispina Sewell.
Mesocyclops (Mesocyclops) leuckarti (Claus).

25. Large connected pool at Uttarbhag. 2. 1. 33. Salinity 4·16 per mille.

Copepoda:

Pseudodiaptomus tollingeri Sewell.
Acartia chilkaensis Sewell.
Acartia (Acartiella) tortaniformis Sewell.
Oithona horai, sp. nov.
Cyclopina longifurca Sewell.
Halicyclops aequoreus (Fischer).
Halicyclops tenuispina Sewell.
Halicyclops propinquus sars.
Mesocyclops (Mesocyclops) leuckarti (Claus).
Mesocyclops (Thermocyclops) rylovi Smirnov.
Laophonte bengalensis, sp. nov.
Stenhelia longifurca, sp. nov.
Parategastes sphaericus var. *similis* Sewell.

26. Piali River, at Uttarbhag. 13. iii. 33. 1st phase of High tide, after a "bore". Salinity 18·08 per mille.

Copepoda:

Paracalanus dubia Sewell.
Acrocalanus inermis Sewell.
Pseudodiaptomus tollingeri Sewell.
Labidocera gangetica, sp. nov. Juv.
Acartia chilkaensis Sewell.
Oithona brevicornis Giesbrecht.
Cyclopina longifurca Sewell.
Laophonte bengalensis, sp. nov.
Stenhelia longifurca, sp. nov.
Cletocamptus confluens (Schmeil).

III. SYSTEMATIC ACCOUNT.

ROTIFERA.

Family ASPLANCHNIDAE.

Genus **Asplanchna** Gosse.

Asplanchna brightwelli Hudson and Gosse.

Asplanchna brightwelli, Hudson and Gosse, 1889, p. 122, pl. xii, fig. 1.
Asplanchna brightwelli, Apstein, 1907, p. 209.

A large number of examples of this species were taken in a tow-netting at Z. S. I. Station 3 (Sample 21) in the northern part of the Salt Lakes

in March 1933. The species appears to be widely distributed throughout fresh water in and around Calcutta.

Family BRACHIONIDAE.

Genus **Brachionus** Ehrenberg.

Brachionus bakeri Ehrb.

Brachionus bakeri, Hudson and Gosse, 1889, II, p. 120, pl. xxvii, fig. 8.
Brachionus bakeri, Rousselet, 1897, p. 329, pl. xvi.
Brachionus bakeri, v. Daday, 1906, p. 120, pl. vii, figs. 6-8.
Brachionus bakeri, v. Daday, 1910, p. 90, pl.iv, figs. 6-14.

This species appears to be an extremely variable one and a number of varieties have been described by Rousselet and von Daday; Rousselet (*loc. cit.*, p. 370) considered that these variations from the typical form were definitely associated with differences in the surroundings; " he had noticed that the *Brachionus* found at the same time were usually of the same varieties, although other varieties might be found at the same place at different times." Examples of the typical form, that agreed closely with the figure given by von Daday (1906, pl. VII, fig. 6), were taken in Tolly's Nullah, (Sample 10, 2nd February 1933). Among the varieties noted in the collection were the following:—

Brachionus bakeri var. **brevispinus** Ehrb.

Brachionus bakeri var., Rousselet, 1897, pl. xvi, fig. 9.

This variety occurred associated with the typical form in Tolly's Nullah (Sample 10, 2nd February 1933).

Brachionur bakeri var. **latissimus** Schm.

Brachionus bakeri var. *latissimus*, v. Daday, 1906, p. 91, pl. iv, figs. 7, 8.

Schmarda described this form as a separate species under the name *B. latissimus*; he obtained his examples from Egypt. Numerous examples of the form were taken in the canals of the Salt Lakes Calcutta (Samples 15 and 16, 28th December 1932).

Brachionus pala Ehrb.

Brachionus pala, Hudson and Gosse, 1889, II., p. 117, pl. xxvii, fig. 3; pl. xxviii, figs. 3, 4.
Brachionus pala, v. Daday, 1910, p. 93, pl. iv, figs. 17, 18, 20.

This species was extremely common and occurred in enormous numbers in the tow-netting taken in Sample 14 in the Canals of the Salt Lakes; it was also present though in steadily decreasing numbers in Samples 15 and 16 on the previous day (28th December 1932).

Brachionus rubens Ehrb.

Brachionus rubens, Hudson and Gosse, 1889, II, p. 119, pl. xxvii, fig. 5.
Brachionus rubens, v. Daday, 1910, p. 94.
Brachionus urceolaris var. *rubens*, Sachse, 1912.

Examples were taken in Tolly's nullah (Sample 10, 2nd February 1933).

Brachionus urceolaris Ehrb.

Brachionus urceolaris, Hudson and Gosse, 1889, II, p. 118, pl. xxvii, fig. 6.
Brachionus urceolaris, v. Daday, 1906, p. 125, pl. vii, fig. 1.
Brachionus urceolaris, v. Daday, 1910, p. 94.

Examples of this species were taken in a tow-netting in the canal of the Salt Lakes, Calcutta, near Chingrighatta on 19th October 1914.

PHYLLOPODA: Cladocera.

Family DAPHNIDAE.

Genus **Daphnia** O. F. Müller.

Up to the present time I have only come across a single species of *Daphnia* in the whole collection. Hitherto the following species have been recorded from India, *Daphnia fusca* Gurney (Gurney, 1906, p. 276) from Kang Kul, Chitral; *Daphnia magna* Straus (Gurney, 1920*a*, p. 146) from Seistan; *Daphnia longispina* (O. F. Müller) from Gyantse, Tibet (von Daday, 1908, p. 330) and *D. longispina* var. *rosea* Sars (Gurney, 1920*a*, p. 146) also from Seistan. The present collection adds another species to the list of those recorded from India and the adjoining country.

Daphnia lumholtzi Sars.

Daphnia lumholtzi, Sars, 1886, p. 18, pl. i, figs. 1-10; pls. iii-iv.
Daphnia lumholtzi, Richard, 1896, p. 219, pl. xxi, fig. 7; pl. xxiv, figs. 5-7.
Daphnia lumholtzi, v. Daday, 1910, p. 147, pl. viii, figs. 11-15.
Daphnia lumholtzi, Gurney, 1911, p. 26.
Daphnia lumholtzi, Gurney, 1916, p. 334.

So characteristic is the appearance of this species that I have no hesitation in referring to it a single example that was taken in the Canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914.

Family SIDIDAE.

Genus **Diaphanosoma** Fischer.

Two species of *Diaphanosoma* are present in the collections.

Diaphanosoma excisum var. **longiremis** Ekman.

Diaphanosoma excisum, Sars, 1885, p. 13, pl. II.
Diaphanosoma excisum var. *longiremis*, Ekman, 1904, p. 1.

Examples of this species occur in the River Hooghly and also in the canal system of the Salt Lakes, Calcutta. In the Hooghly River they have been taken at Nawabganj, opposite the Pulta Water-works and in the vicinity of Howrah Bridge; a single specimen has also been taken in Tolly's Nullah (Sample 10, 2nd February 1933). Specimens have also been obtained at Chingrighatta in the canals of the Salt Lakes both on 19th October 1914 and again inside the Dhappa lock gates near Chingrighatta on 20th October 1930. As I have recorded elsewhere, this species occurs in the Tank of the Indian Museum.

Diaphanosoma modiglianii Richard.

Diaphanosoma modiglianii, Richard, 1896, p. 363, pl. xv, figs. 13-14; pl. xvi, fig. 22.

This species was described by Richard from Sumatra. The present examples appear to be rather larger than Richard's original specimens, being 1·156 mm. in length by 0·444 mm. in width. The head is produced in the characteristic conical shape and there is a well-marked bulge on the ventral aspect in the region of the eye. The shell-margin in my examples is armed with a number of groups of spines, in which the size of the spine deceases from before backwards; as a rule there are 5 to 6 spines in each group. The shell margin is not inturned and the antennae do not quite reach the posterior margin of the shell. Several examples of this species were taken in a tow-netting at Chingrighatta in the Salt Lakes, Calcutta, on 19th October 1914.

Genus **Ceriodaphnia** Dana.

Ceriodaphnia rigaudi Richard.

Ceriodaphnia rigaudi, Gurney, 1907, p. 21.

This species has already been recorded from the environs of Calcutta by Gurney and it appears to be an inhabitant of most of the areas of the water in the locality. As I have already recorded, it occurs in the Tank of the Indian Museum, Calcutta, and further examples have been obtained from the Hooghly River at Naihati and near the Howrah bridge, as well as from the canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914. Gurney (*loc. cit.*) has recorded its presence in brackish ponds at Port Canning in the Gangetic Delta, the water of which ranges in salinity from almost *nil* during the rains, through 12·13 per thousand in December to 23·16 in March (*vide* Annandale, 1907, p. 36).

Ceriodaphnia cornuta Sars.

Ceriodaphnia cornuta, Sars, 1886, p. 26, pl. v, figs. 1-3.

Examples of this form were taken in the canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914.

Genus **Moina** Baird.

Moina dubia Richard.

Moina dubia, Richard, 1892, p. 527, figs. 1-2.
Moina dubia, Gurney, 1911, p. 27, pl. ii, figs. 1, 2.
Moina dubia, Gurney, 1927, p. 66, text-figs. 4, e, f.

Examples of what I take to be this species were taken in several localities in and around Calcutta. I have elsewhere recorded its presence in the Tank of the Indian Museum, and further examples have been taken in the Hooghly River at Naihati, near the Pulta Water-works and near the Howrah Bridge. It also occurred in the tow-netting taken at Chingrighatta on the Canals of the Salt Lakes, Calcutta, on 19th October 1914 and inside the lock gates at Dhappa on 20th October 1930; as well as in Samples 15, 16 and 17 on 28th December 1932.

Family CHYDORIDAE.

Genus **Alona** Baird.

? **Alona quadrangularis** O. F. Müller.

Alona quadrangularis, Keilhack, 1907, p. 82, figs. 193, 194, 195.
Alona quadrangularis, v. Daday, 1910, p. 134, pl. vii, fig. 17.

A single example of what seems to be this species was taken in the Canal of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914.

Genus **Chydorus** Leach.

Chydorus sphaericus (O. F. Müller).

Chydorus sphaericus, Ekman, 1904, p. 26.
Chydorus sphaericus, Gurney, 1906, p. 278.
Chydorus sphaericus, Keilhack, 1909, p. 102, fig. 248.
Chydorus sphaericus, v. Daday, 1910, p. 121, pl. vi, fig. 5.
Chydorus sphaericus, Gurney, 1911, p. 30.

Two examples of this species were taken in a tow-netting at Chingrighatta in the Salt Lakes, Calcutta, on 19th October 1914.

COPEPODA : Calanoida.

Family PARACALANIDAE.

Genus **Paracalanus** Boeck.

Paracalanus dubia Sewell.

Paracalanus dubia, Sewell, 1912, p. 330, pl. xv, figs. 1-5.
Paracalanus crassirostris, forma *sewelli*, Früchtl, 1924, p. 36.
Paracalanus dubia, Sewell, 1929, p. 76, fig. 29.

This species was first described by me from the mouth of the Rangoon river in water that showed a specific gravity of 1002. In the present collections examples have been taken in the tow-netting from Diamond Harbour on the Hooghly River.

Genus **Acrocalanus** Giesbrecht.

Acrocalanus inermis Sewell.

Acrocalanus inermis, Sewell, 1912, p. 334, pl. xvi, figs. 1-9.
Acrocalanus similis, Sewell, 1914, p. 211, pl. xvii, figs. 3-5.
Acrocalanus inermis, Sewell, 1924, p. 781.
Acrocalanus inermis, Früchtl, 1924, p. 61.
Acrocalanus inermis, Sewell, 1929, p. 81.

I have already (1929) pointed out that this species is in the main an inhabitant of brackish water and is apparently confined to the coastal region. It appears to be widely distributed from the mouth of the Hooghly and the Chilka Lake on the west to the Malay Archipelago. In the present collections it occurs in tow-nettings from the lower reaches of the Hoogly River, commencing from Budge Budge, and has also made its way into Tolly's Nullah.

Family DIAPTOMIDAE.

Genus **Diaptomus** Westwood.

Diaptomus blanci Guerne and Richard.

Diaptomus blanci, Guerne and Richard, 1896, p. 53.
Diaptomus blanci, Sewell, 1924, p. 788.

Examples of this species have previously been recorded by me from the Chilka Lake. In the present collections specimens have been obtained from the Hooghly River at Naihati, at Nawabganj, near the Pulta Water-works and in the vicinity of the Howrah Bridge. It seems probable that this is a true fresh-water species and that its presence in such an area as the Chilka Lake is due to its having been washed in during the rainy season.

Diaptomus cinctus Gurney.

Diaptomus cinctus, Gurney, 1907, p. 29, pl. i, figs. 11-12.
Diaptomus cinctus, Sewell, 1924, p. 788, pl. xlv, fig. 4.

Like the last, this species occurs frequently in the Hooghly River and has been taken at Naihati and Nawabganj, while two examples, one of them an ovigerous female, were taken in Tolly's Nullah in Sample 10 (2nd February 1933). Specimens have also been obtained in the canals of the Salt Lakes, Calcutta, in samples 14, 15, and 16 on 28th-29th December 1932.

Like the last, this species appears to be a true fresh-water inhabitant and has but little power of adaptation to a brackish-water habitat.

Diaptomus contortus Gurney.

Diaptomus contortus, Gurney, 1907, p. 28, figs. 9, 10.
Diaptomus contortus, Sewell, 1924, p. 788, pl. xlv, fig. 5.

This species has been taken at Nawabganj, near the Pulta Water-works and near the Howrah Bridge in the Hooghly River; it also occurred at Chingrighatta or its vicinity on all the three occasions on which collections were made from that locality, namely at Chingrighatta on 19th October 1914, inside the lock-gates at Dhappa on 20th October 1930 and in sample 14 on 29th December 1932. While usually found in fresh water, this species would appear to be somewhat more adaptable to a brackish water habitat than the preceding two species.

Diaptomus orientalis Brady.

Diaptomus orientalis, Brady, 1886, p. 296, pl. xxxvii, figs. 21-26.

Examples of this species were obtained in the Hooghly River at Nawabganj (Sample 3).

Diaptomus strigilipes Gurney.

(Text-fig. 2 *a*.)

Diaptomus strigilipes, Gurney, 1907, p. 30, figs. 18-20.
Diaptomus strigilipes, Sewell, 1924, p. 788.

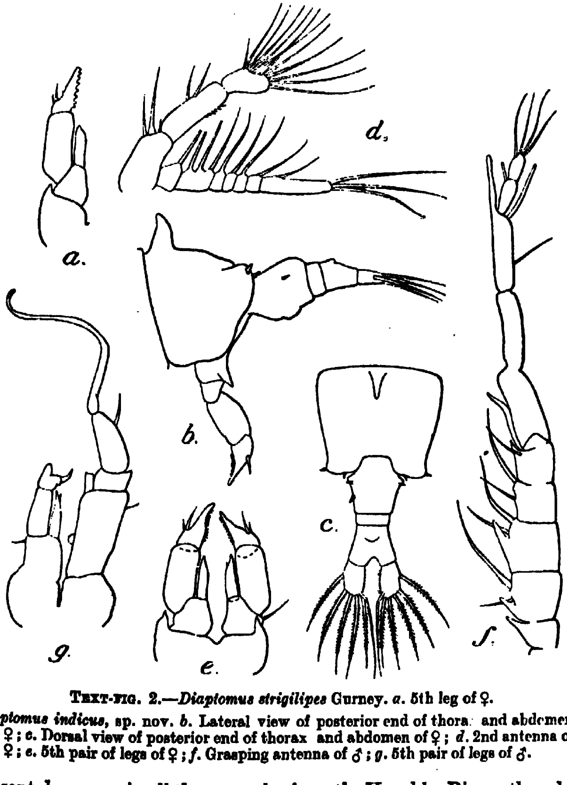
This species is now known to occur in Chakradharpur, in Chota Nagpur, and in Bankipur and Chittagong in Bengal.

A few examples of this species were taken in the Hooghly River in the vicinity of Howrah Bridge.

Diaptomus indicus, sp. nov.

(Text-fig. 2 *b-g*.)

Among the examples of *Diaptomus* from the river Hooghly were a few that appear to represent a new species, though at first sight they are liable to be mistaken for *Diaptomus chaffanjoni* or *D. sarsi*, owing to the presence on the dorsal aspect of the 4th thoracic segment in the females of a median triangular process (Text-fig. 2 *b* and *c*). This process is not



TEXT-FIG. 2.—*Diaptomus strigilipes* Gurney. *a*. 5th leg of ♀. *Diaptomus indicus*, sp. nov. *b*. Lateral view of posterior end of thorax and abdomen of ♀; *c*. Dorsal view of posterior end of thorax and abdomen of ♀; *d*. 2nd antenna of ♀; *e*. 5th pair of legs of ♀; *f*. Grasping antenna of ♂; *g*. 5th pair of legs of ♂.

present, however, in all the examples from the Hooghly River, though in numerous examples of the same species from a tank in the P. W. D. bungalow compound, Ghorawal, Mirzapore, it was invariably present. Another species with which this form is liable to be confused is *Diaptomus*

strigilipes Gurney, and this is especially the case in the females when the dorsal process is absent.

♀: Total length 1·083 mm.

The proportional lengths of the cephalothorax and abdomen are as 41 to 11, so that the posterior region is contained 3·727 times in the length of the anterior region. The anterior margin is rounded and there is a pair of fine, ventrally-directed rostral spines. The posterior margin of the last thoracic segment is as a rule slightly expanded and each expansion is furnished with two short stout spines. In some examples the extension of the left side is more marked than that on the right and almost approaches a wing-like structure.

The abdomen consists of three segments, that have with the furcal-rami the following proportional lengths :—

Abdominal segment . . .	1-3	4	5	Furca.
	43	7	29	21=100.

In *Diaptomus strigilipes* the corresponding proportions are 47, 10, 23, 10. As in *D. strigilipes*, there is on the right side of the genital segment a short process that bears on its outer aspect a short stout spine, while on the left side rather nearer the posterior margin is a stout spine, that in the present form arises from the general surface of the segment, whereas in *D. strigilipes* it arises from a rounded prominence (*cf.* Gurney, 1907, Pl. ii, fig. 18).

The 1st antenna overreaches the tip of the furcal ramus by four or five segments. The proportional lengths of the segments are as follows :—

Segment . .	1	2	3	4	5	6	7	8	9	10	11	12	13
	40	29	20	23	26	26	27	31	34	37	34	51	56

	14	15	16	17	18	19	20	21	22	23	24	25
	56	56	53	53	55	49	44	44	44	46	40	26=1000.

The 2nd antenna (Text-fig. 2 *d*) and mouth-parts are as in other members of the genus.

The 5th pair of legs (Text-fig. 2 *e*) closely resembles those of *Diaptomus strigilipes*. The basal segment bears a spine-like projection on its posterior face. The endopod reaches nearly to the distal end of the proximal segment of the exopod and ends in a conical point. The distal segment of the exopod is armed along its lower margin with a row of regular, rounded cusps and not an irregular row of teeth as in *D. strigilipes* (*cf.* Text-fig. 2 *a*).

♂: Total length 1·271 mm.

The proportional lengths of the cephalothorax and abdomen are as 42 to 19, so that the posterior region is contained 2·21 times in the length of the anterior region. There is no trace of any prominence in the dorsal region of the last thoracic segment in this sex; nor are the posterior thoracic margins expanded. On each side the last thoracic segment bears a minute sensory seta laterally.

The abdomen consists of the usual five segments, that have the following proportional lengths :—

Abdominal segment . .	1	2	3	4	5	Furca.
	11	21	19	21	10	18=100.

The 1st segment is short and bears a single, somewhat delicate spine on its postero-lateral margin on the right side. The 4th segment is asymmetrical and is produced backwards on the right side in a rounded prominence.

In the grasping antennæ (Text-fig. 2, *f*) segment 13 bears a stout spinous process; segments 14 and 15 both bear a stout process and two unequal setae, the larger of which arises from the distal angle. Segment 17 bears a narrow hyaline lamella that is produced forward over the proximal part of segment 18. Segments 18 bears a curved hyaline lamella on its anterior aspect. Segment 19, 20, and 21 are fused; a narrow hyaline lamella runs along the proximal two-thirds of the anterior margin. Segment 23 bears a long and narrow process that extends distally almost to the tip of the last segment.

In the 5th pair of legs (Text-fig. 2, *g*) the left leg is very short and hardly reaches beyond the distal end of the 2nd basal segment of the right leg. The endopod of the left leg is long and tapers to a conical point. The distal segment of the exopod is small and ends distally in a rounded prominence, while a stout but short seta springs from the inner aspect. In the right leg the endopod is very short and only reaches to the distal end of the proximal segment of the exopod. The 2nd segment of the exopod bears a curved spine that arises from about the middle of the segment. The terminal segment is slender and is much curved. In its general appearance this appendage closely resembles that of *D. strigilipes*, but the endopod of the right leg is much shorter.

Diaptomus viduus Gurney.

(Text-fig. 3, *a-d*).

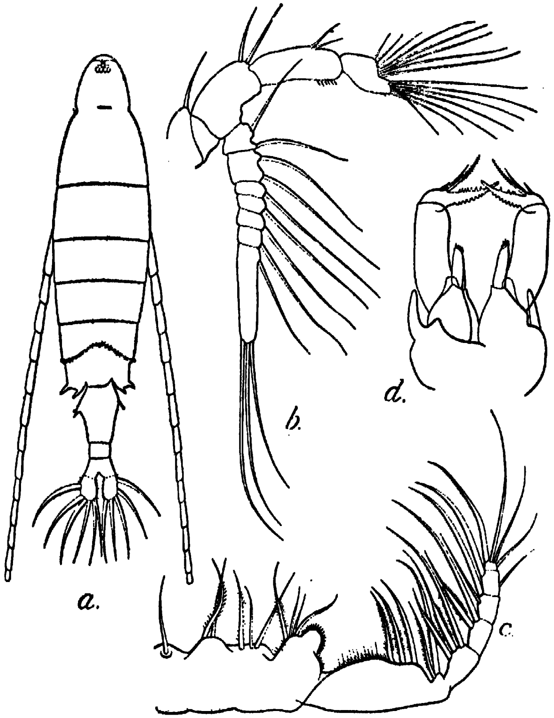
Diaptomus viduus, Gurney, 1916, p. 338, pl. II, fig. 11-14.
(*non Diaptomus viduus*, Kikuchi, 1928).

This species is widely distributed around Calcutta. Examples have been taken in the Hooghly River at Nawabganj, near the Pulta Waterworks and in the vicinity of Howrah Bridge. Up to the present time this species has been known only from the male which was described by Gurney from Ceylon. The species described by Kikuchi from Japan under this name is not the same species, though closely related to it. I give below a description of the hitherto unknown female.

♀: Total length ranges from 1·700 to 2·00 mm. The proportional lengths of the cephalothorax and abdomen are as 3·135 to 1.

The body (Text-fig. 3 *a*) is comparatively robust and tapers towards each end, the greatest breadth being in the region of the 1st thoracic segment. A well-marked groove traverses the cephalon and the 1st thoracic segment is separate, though the line of separation is not so clearly defined as in the case of the more posterior segments. The 4th and 5th thoracic segments are fused, though there is a well-marked constriction across the body at the site of fusion. The posterior margin of the 4th segment is also demarcated by a transverse row of short spines that passes across the dorsum. The posterior lateral angles are expanded

and bear on each side a pair of short and usually blunt spines that are directed outwards.



TEXT-FIG. 3.—*Diaptomus viduus* Gurney. *a.* Dorsal aspect of ♀; *b.* 2nd antenna of ♀; *c.* Maxilliped of ♀; *d.* 5th pairs of legs of ♀.

The abdomen consists of three segments and the furcal rami. These have the following proportional lengths :—

Abdominal segment .	1-3	4	5	Furca	
	53	12	15	20	= 100.

The genital segment is slightly asymmetrical; each bears a short spine, that on the right side being situated somewhat more anteriorly than that on the left. The segment is itself slightly produced at the point of origin of the latter spine and the spine is bifid, a small accessory spine arising near the base. The furcal rami are short and broad, the relative dimensions being in the proportion of 9 in length to 8 in breadth. The inner margins and the proximal part of the outer margin are fringed with delicate hairs. The furcal setae are short and stout.

The 1st antenna overreaches the tip of the furcal ramus by the last three or four segments. The proportional lengths of the segments are as follows :—

Segment .	1-2	3	4	5	6	7	8	9	10	11	12	13	14
	87	22	22	24	25	29	33	37	36	36	53	58	57

15	16	17	18	19	20	21	22	23	24	25	
57	55	53	50	48	41	41	39	39	35	23	1000.

The 1st and 2nd segments are fused together but all the remaining segments are separate.

In the 2nd antenna (Text-fig. 3*b*) the exopod is half as long again as the endopod. Basal 1 bears a single seta and Basal 2 has two setae at its distal external angle. The 1st segment of the endopod bears two setae at about two-thirds the length of its external margin and there is a comb of curved needle-like spines along the distal third of the inner surface ; the terminal segment is also armed with a group of spines on its inner aspect and distally bears 7 and 8 setae on its outer and inner lobes respectively. In the exopod the 1st and 2nd segment each bears two setae ; segments 3-6 each carry a single seta, whereas segment 7 has a single seta arising near the base and three from its distal end.

The mandible and maxilla closely resemble those of *Diaptomus castor* (Jurine) as figured by Sars (1901-3, Pl. lviii). The maxilliped (Text-fig. 3*c*) is more slender than the corresponding appendage in *Diaptomus castor*. In the 1st basal segment the proximal lobe bears a single seta, the 2nd, 3rd and 4th lobes bear respectively two, three and four setae ; the distal anterior angle is produced in a rounded prominence and is provided with a row of short needle-like spines. In the 2nd basal segment the anterior margin is armed in its proximal half with a row of fine curved spines and a number of long hairs also arise from this part of the surface ; the distal part of this border bears three setae and a further pair of unequal setae arise from the distal angle. The endopod consists of five segments ; of these the 1st bears one long, curved seta and two shorter setae that are thickened in their basal two-thirds and are finely serrated ; segments 2 and 3 each bear two setae, of which the distal is long and serrated ; the proximal seta on the 2nd segment is, like the shorter setae on segment 1, swollen in its basal half and is serrated on both margins ; segment 4 bears a single long seta on its inner margin and a small seta arises from its outer aspect ; segment 5 bears one large stout seta and three smaller and more delicate ones.

In the 1st swimming leg the proximal basal segment bears a number of fine scattered needle-like spines on its outer aspect, and a single seta arises from its distal inner angle. The 2nd basal segment bears a small tuft of fine hairs on its proximal outer angle. The exopod consists of three segments, of which the 2nd is without a marginal spine. The endopod is composed of two free segments only.

The 2nd, 3rd and 4th pairs of legs resemble those of other members of the genus.

The 5th pair of legs (Text-fig. 3*d*) are as figured. The 1st basal segment bears a stout spine-like process at its distal external angle. The 2nd basal segment bears the endopod at its inner distal angle and

close to the articulation is a rounded or somewhat truncated projection. The 1st free segment of the exopod is stout, and the 2nd segment is slightly swollen at the base and tapers to a point-in length it is but little shorter than the proximal free segment and on each side there is a row of stout teeth, the actual number of which appear to vary even in the same individual, as in the one figured in which there were eight teeth on the outer margin of one and only four on the other.

This species comes very close to *Diaptomus strigilipes* Gurney and the form described by Kikuchi (1928) under the name *Diaptomus viduus* from Japan, but the differences are sufficient to warrant their being regarded as distinct species.

Genus **Pseudodiaptomus** Herrick.

Pseudodiaptomus annandalei Sewell.

Pseudodiaptomus annandalei, Sewell, 1919, p. 5, pl. x, fig. 9.
Pseudodiaptomus annandalei, Sewell, 1924, p. 787, pl. xliv, fig. 2.
Pseudodiaptomus annandalei, Sewell, 1932, p. 240.

This species was first described by me from the Chilka Lake and has since been obtained at Quilon, Travancore and in the Kuran River, Perak. It has been taken in the Canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914, and inside the lock-gates at Dhappa Lock on 20th October 1930, but it had completely disappeared from the Locality on 29th December 1932. It was, however, taken in samples 15-20 in the Canals and the Salt Lakes proper in 1928-32 and in the Salt Lakes near Naobad (Sample 22) on 2nd February 1933. There seems but little doubt that this is a brackish-water form (*vide* Sewell, 1932, pp. 233, 234).

Pseudodiaptomus binghami Sewell.

Pseudodiaptomus binghami, Sewell, 1912, p. 337, pl. xvii, figs. 8-11.
Pseudodiaptomus binghami, Sewell, 1919, p. 7.
Pseudodiaptomus binghami, Sewell, 1924, p. 876, pl. xlv, fig. 2.
Pseudodiaptomus binghami, Sewell, 1932, p. 240.

This species was first described from the estuary of the Rangoon River and was later taken in the Chilka Lake. It has been taken in Tolly's Nullah in sample 10 (2nd February 1933) and at Gangajoara (Sample 11, 2nd February 1933); it occurred in the Canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914 and inside the lock-gates at Dhappa on 20th October 1930; but had disappeared from this locality on 29th December 1932. It was taken in samples 5 from Budge Budge in the Hooghly River and has been taken in the Salt Lakes themselves at Naoabad (2nd February 1933) and at Uttarbhag (2nd January 1933). This species is frequently associated with *Pseudodiaptomus annandalei* Sewell and, like it, is a denizen of brackish water. The range of specific gravity of water in which it has been taken extends from 1002 in the Rangoon River Estuary and 997·0 at 28·5°C in the Chilka Lake to 1026·25 at 15·0 C in the latter area. It thus possesses a wide range of adaptation.

Pseudodiaptomus lobipes Gurney.

Pseudodiaptomus lobipes, Gurney, 1907, p. 27, figs. 3-8, 23-24.
Pseudodiaptomus lobipes, Sewell, 1924, p. 786, pl. xlv, fig. 1.

This species was described by Gurney (1907) from specimens taken in certain Tanks in Calcutta and I have since recorded its presence in the Chilka Lake. It has also been taken in the Mahanaddi River. In the present collections it occurs in all tow-nettings from the upper or fresh, water reaches of the Hooghly River, namely from Naihati, Nawabganj, near the Pulta Water-works and in the vicinity of the Howrah Bridge. It would appear to be a purely fresh-water form.

Pseudodiaptomus tollingeri Sewell.

Pseudodiaptomus tollingeri, Sewell, 1919, p. 2, pl. x, fig. 8.
Pseudodiaptomus tollingeri, Sewell, 1924, p. 787, pl. xlv, fig. 3.
Pseudodiaptomus tollingeri, Sewell, 1932, p. 241.

This species has now been taken in the Chilka Lake, and in the Canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914, and in Sample 17 on 28th December 1932 as well as in samples 23, 25 and 26 from Uttarbhag. It appears to be essentially a brackish-water form with only a moderate range of adaptability to fresh-water conditions.

Pseudodiaptomus hickmani Sewell.

Pseudodiaptomus hickmani, Sewell, 1912, p. 364, pl. xxii, figs. 1-7.
Pseudodiaptomus hickmani, Sewell, 1924, p. 786.
Pseudodiaptomus hickmani, Sewell, 1932, p. 235.

A single examples of the female of this species was taken in the tow-netting at Diamond Harbour on the Hooghly River (Sample 8).

Pseudodiaptomus aurivillii Cleve.

Pseudodiaptomus aurivillii, Cleve, 1901, p. 48, pl. vi, figs. 11-22; pl. vii, figs. 1, 2.
Pseudodiaptomus aurivillii, Sewell, 1924, p. 240.
Pseudodiaptomus aurivilli, Früchtl, 1924, p. 51.

Several examples of the female of this species were taken in a tow-netting at Diamond Harbour (Sample 8).

Family PONTELLIDAE.

Genus **Labidocera** Lubbock.

Labidocera gangetica, sp. nov.

Labidocera euchaeta, Stage I, Sewell, 1912, p. 339, pl. xviii, figs. 1-9.
Labidocera euchaeta, forma *major*, Sewell, 1932, p. 361.

This form was first described by me from the Rangoon River estuary; it has also been taken in the Ramree River and at Chittagong. I have hitherto been inclined to regard it as a large dimorphic form of *Labidocera euchaeta* Giesbrecht with which in previous collections it was associated, though in my last paper (1932, p. 362) I pointed out that a comparison

of the segmental lengths in this form and in *Labidocera euchaeta* Gies brecht showed distinct differences from what one would expect if the were two forms of the same species, and I then remarked that "suc a difference from the normal leads one to suspect that one is not dealin with two stages in the same life history". In the present collections number of examples of this form were taken at Diamond Harbour an associated with adults of both sexes were numerous immature forms It thus seems certain that this is a different species from *L. euchaet* and I, therefore, give it the name *L. gangetica*. It was taken in th Hooghly River at Diamond Harbour and Achipur and in the Piali Rive at Uttarbhag (Samples 6, 8 and 26), and appears to be an estuarine form

Genus **Pontella** Dana.

Pontella andersoni Sewell.

Pontella andersoni, Sewell, 1912, pp. 323, 344, and 370, pl. xx, figs. 1-6.
Pontella andersoni, Sewell, 1932, p. 375.

This species was first described from the coast of Burma off Chitta gong. Since then it has been taken at several stations in the Mergu Archipelago. Its presence at Diamond Harbour on the Hooghly Rive (Sample 8) is interesting, as it clearly indicates that the species possesse a considerable degree of adaptation to brackish-water conditions.

Family ACARTIIDAE.

Genus **Acartia** Dana.

Sub-genus **Acanthacartia** Steuer.

Acartia (Acanthacartia) chilkaensis Sewell.

Acartia chilkaensis, Sewell, 1919, p. 9, pl. ix, figs. 1-5.
Acartia (Acanthacartia) chilkaensis, Sewell, 1932, p. 395.

This species was first described from the Chilka Lake from wate the density of which ranged from 997·5 at 28·6°C to 1003·25. In th present collections examples have been taken in the Hooghly River a Naihati, at Nawabganj and in the vicinity of the Howrah Bridge; i Tolly's Nullah in sample 10 (2nd February 1933) and at Gangajoar (2nd February 1933). In the Canal system of the Salt Lakes it is foun in tow-nettings 15, 16 and 17 (28th December 1932), but not in Sampl 14 from Chingrighatta, though it was present in the near vicinity of thi area in previous years, as is shown by its presence at Chingrighatta o 19th October 1914 and inside the lock-gates at Dhappa on 20th Octobe 1930. In the Salt Lakes themselves it has been taken at Naoabad an in pools at Uttarbhag (Samples 22-24).

Acartia (Acanthacartia) plumosa T. Scott.

Acartia (Acanthacartia) plumosa, Steuer, 1923, p. 112, figs. 110-114.
Acartia (Acanthacartia) plumosa, Sewell, 1932, p. 395.

In other parts of the world this species has been recorded from sal or brackish water, namely from Loanda Harbour in the Gulf of Guinea

(T. Scott, 1894, p. 66, Pl. VII, figs. 22-32) and in Banana Creek, Congo River, where the specific gravity of the water was 1008·7. Examples were taken in the Canals of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914, and from the Hooghly River at Falta and Diamond Harbour (Samples 7 and 8).

Sub-genus **Odontacartia** Steuer.

Acartia (Odontacartia) spinicauda Giesbrecht.

Acartia (*Odontacartia*) *spinicauda*, Steuer, 1923, p. 27, figs. 130-133.
Acartia spinicauda, Sewell, 1924, p. 789.
Acartia (*Odontacartia*) *spinicauda*, Sewell, 1932, p. 397.

Examples of this species have been recorded from the Chilka Lake in water the density of which ranged from that of the Bay of Bengal to as low as 1010·0 at 26·5°C. A single example was taken in the tow-netting from the Canal at Chingrighatta, Salt Lakes, Calcutta on 19th October 1914 while numerous examples occurred in the Tow-netting from Diamond Harbour on the Hooghly River (Sample 8).

Sub-genus **Acartiella** Sewell.

Acartia (Acartiella) tortaniformis Sewell.

Acartia tortaniformis, Sewell, 1912, p. 346, pl. xxi, figs. 1-10.
Acartia (*Acartiella*) *tortaniformis*, Steuer, 1923, p. 100.
Acartia (*Acartiella*) *tortaniformis*, Sewell, 1932, p. 393.

This species was first recorded from the region of the Rangoon estuary, in water that had a density of 1002; and I have since obtained specimens from tow-nettings off Hainguy Island on the Burma Coast and from the river at Chittagong. Unfortunately I have no records of the salinity of the water in these two latter localities. In the present collections specimens occur in the Hooghly River from Nawabganj and near the Pulta Water-works as far down as Diamond Harbour. It also occurs in Tolly's Nullah at Magrahat (Sample 9, 7th March 1933) and at Gharia Bridge and Gangajoara, Samples 10, 11 (2nd February 1933). In the Canal system of the Salt Lakes, Calcutta, it was present in samples 16 and 17 (28th December 1932), though in fewer numbers at the latter station; it was present at Chingrighatta on 19th October 1914, but appears to have disappeared from that locality in 1930. In the Salt Lakes themselves it has been taken at Uttarbhag in pools (Samples 24 and 25).

Acartia (Acartiella) major Sewell.

Acartiella major, Sewell, 1919, p. 15, pl. ix, fig. 8; pl. x, figs. 2, 3, 6.
Acartia (*Acartiella*) *major*, Sewell, 1932, p. 393.

Originally described from the Chilka Lake collections, this species is common in the lower reaches of the Hooghly River at Budge Budge and Diamond Harbour, where it occurs in association with *Acartia* (*Acartiella*) *tortaniformis* Sewell.

CYCLOPOIDA.

Family OITHONIDAE.

Sub-family OITHONINAE.

Genus **Oithona** Baird.

Oithona brevicornis Giesbrecht.

Oithona brevicornis, Sewell, 1924, p. 792.
Oithona brevicornis, Kiefer, 1929, p. 8.

This species has previously been obtained from brackish-water areas, such as a brackish-water lake in Verlaten Island, Sunda Straits, and in the Chilka Lake. In this latter region it occurred in water having a density ranging from 1015·0 at 15°C. to 1003·25. Examples were taken in the Canal system of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914, but it has since disappeared from this locality. It was abundant in the lower reaches of the Hooghly River and in the Piali River (Samples 8 and 26.).

Oithona horai, sp. nov.

(Text-fig. 4, *a-j*.)

♀: Total length 0·521 to 0·604.

The proportional lengths of the anterior and posterior regions of the body are as 1·07 to 1.

The anterior end is somewhat truncated. A rostrum proper appears to be absent and the antero-ventral part of the cephalon is produced downwards in a rounded prominence, very similar to that of *Limnoithona sinensis* Burckhardt. The widest part of the anterior region of the body is at the posterior margin of the cephalon. The line of segmentation between the cephalon and the 1st thoracic segment of the body is less marked than the following divisions. The posterior margin of the cephalon is somewhat convex so that the 1st thoracic segment appears to be narrow in the mid-dorsal line. The posterior margins of the 4th thoracic segment are rounded.

The abdomen consists of four free segments and the furcal rami; segments 1 and 2 being fused. The proportional lengths of the segments are as follows:—

Abdominal segment . . .	1-2	3	4	5	Furca	
	32	15	20	14	19	=100

The furcal ramus is long and closely resembles that of *Limnoithona sinensis* in that it is almost exactly one-twelfth of the whole body length. The outer furcal seta (seta 5) arises from the external border at the junction of the proximal and 2nd quarter. The distal setae closely resemble those of the genus *Oithona* in that the inner and outer (setae 1 and 4) are quite small. The dorsal accessory seta is long. The proportional lengths of these setae are as follows:—

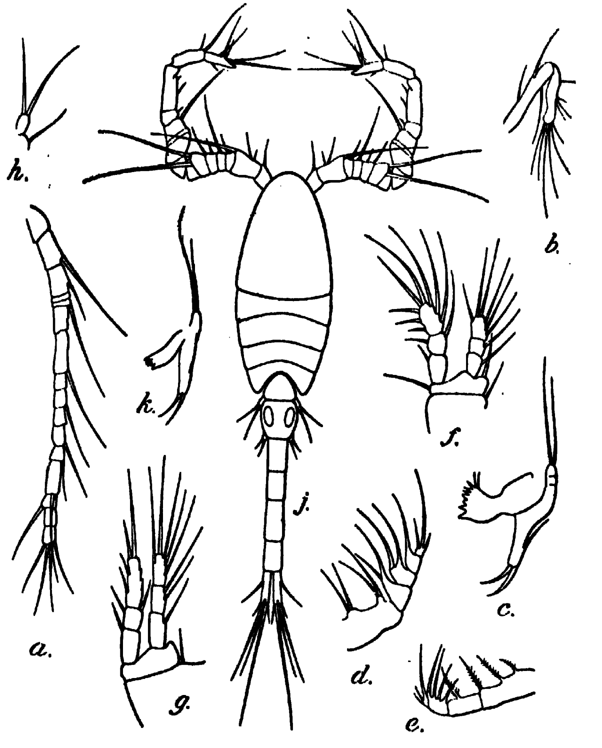
Seta 1	5
Seta 2	40
Seta 3	27
Seta 4	5
Seta 5	10
Dorsal Seta	29

The 1st antenna (Text-fig. 4*a*) reaches back to the posterior margin of the anterior region of the body. It consists of 16 free segments that have the following proportional lengths:—

Segment	1	2	3	4	5	6	7	8	9
	114	86	100	14	14	86	114	43	50

	10	11	12	13	14	15	16	
	43	43	57	100	36	57	43	=1000

As in the genus *Oithona* the setae arising from the segments are longer and slightly stouter than the terminal setae.



Text-fig. 4.—*Oithona horai*, sp. nov. *a*. 1st antenna of ♀; *b*. 2nd antenna of ♀; *c*. Mandible of ♀; *d*. 2nd maxilla of ♀; *e*. maxilliped of ♀; *f*. 1st swimming leg of ♀; *g*. 2nd swimming leg of ♀; *h*. 5th leg of ♀; *j*. Dorsal view of male; *k*. Mandible of ♂.

The 2nd antenna (Text-fig. 4 *b*) consists of two joints only; the distal two segments being fused together. In this respect the present species closely resembles *Limnoithona sinensis*, but differs in that a single stout seta arises from the inner margin of the proximal segment.

The mandible (Text fig. 4c) possesses a stout tooth-plate armed with short but stout teeth of which the first is separated slightly from the rest and is somewhat stronger; the third tooth is small. The 2nd basal segment carries two equal stout setae. I have been unable to detect the presence of an inner ramus and this appears to be reduced and represented by a single seta. The outer ramus bears five setae that are long and slender.

In the maxilla the tooth-plate bears several long stout spines; the 3rd lobe bears three setae, of which the middle one is stout, as in the genus *Oithona.*

The 2nd maxilla (Text-fig. 4d) and maxilliped (Text-fig. 4e) are of the *Oithona* type.

In the swimming legs (Text-fig. 4*f,g*) the exopods of all four pairs bear 1, 1, 3 marginal spines.

The 5th leg (Text-fig. 4h) consists of a basal segment that bears a long seta and a single small free segment carrying two setae.

While closely resembling in its external appearance *Limnoithona sinensis* Burckhardt, there can be no doubt that this form belongs to the genus *Oithona.*

♂: Total length 0·542 mm.

The proportional lengths of the anterior and posterior regions of the body are as 1·048 to 1.

The body (Text-fig. 4j) is slightly smaller and is considerably more slender than in the female. The widest part of the anterior region is at the posterior margin of the cephalon. This margin is somewhat convex, so that the 1st thoracic segment appears to be narrow in the mid-dorsal line. The posterior thoracic margins are rounded.

The abdomen consists of five free segments, that have the following proportional lengths :—

Abdominal segment . .	1	2	3	4	5	Furca.
	19	16	15	21	14	15=100

Both the 1st antennae are modified into the usual grasping organ and in their general structure agree with those of other members of the genus *Oithona.*

Examples of this new species were taken from isolated pools at Uttarbhag (Samples 24 and 25). I have much pleasure in dedicating this species to Dr. S. L. Hora, Zoological Survey of India, who has been associated with me in the present study and who made a number of collections of plankton for me.

CYCLOPOIDA.

Family CYCLOPINIDAE.

Sub-family CYCLOPININAE.

Genus **Cyclopina** Claus.

Cyclopina longifurca Sewell.

Cyclopina longifurca, Sewell, 1924, p. 794, pl. xlvii, fig. 2.
Cyclopina longifurca, Kiefer, 1929, p. 16.

Originally described from specimens taken in the Chilka Lake in water that had a density of 997·0 at 31·5 C. Further examples have

been obtained from weed-washings in the sea at Tuticorin, South India, and also in the Canal system of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914.

Cyclopina minuta, sp. nov.

(Text-fig. 5, *a-f.*)

Examples of both sexes of a species of *Cyclopina* that appears to be new, were taken in the Hooghly River in water that was absolutely fresh.

♀: Total length: 0·433 to 0·500 mm.

The proportional lengths of the anterior and posterior regions of the body are as 5 to 4. The anterior end (Text-fig. 5*a*) is rounded. The cephalon and 1st thoracic segment are separate and the cephalon is equal in length to the whole five thoracic segments. The lateral margins of the thoracic segments are rounded and are not produced.

The abdomen consists of four free segments; segments 1 and 2 are fused together in the genital segment. The proportional lengths of the segments are as follows:—

Abdominal segment	1-2	3	4	5	Furca.	
	39	14	12	18	17	= 100

The anterior part of the genital segment is somewhat swollen and is grooved on the lateral margins. The anal segment is armed with a row of needle-like spines along the articulation of the furcal rami. The furcal rami are about twice as long as broad. Of the furcal setae four arise from the distal end and the 5th from about the middle of the outer margin. The inner seta is small and delicate and the 2nd seta is nearly twice as long as the third. The 4th and 5th setae are subequal and are about one-third the length of the 3rd.

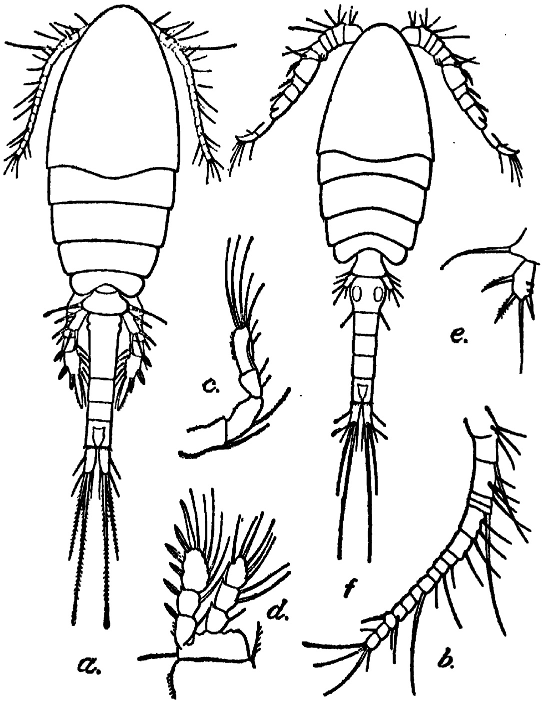
The 1st antenna (Text-fig. 5*b*) is only as long as the cephalic segment and consists of 17 segments, thus resembling *Cyclopina belgica* Giesbrecht and *C. pusilla* Sars. The three proximal joints are moderately long. Segments 1 and 2 appear to be fused. The second joint consists of the fused segments 3 and 4 and the 3rd of segments 5, 6 and 7. The next two joints are short, representing segments 8 and 9. The sixth joint is formed by the fusion of segments 10, 11 and 12. The seventh joint is about equal to the sixth, but is composed of only two segments, namely 13 and 14. Segments 15 to 23 are separate and segments 24 and 25 are fused.

In the 2nd antenna (Text-fig. 5*c*) the third segment is about half the length of the second; the terminal segment is considerably longer than the 3rd and is fringed along the distal half of its lower border with fine needle-like spines.

The mouth-parts and swimming-legs are similar to those of other members of the genus.

The 5th leg (Text-fig. 5*e*) consists of a basal segment that is fused with the thoracic segment and bears a long seta on its outer border; the free segment is comparatively short and stout and bears two spines

with a single seta between them on its distal margin and a third spine about the middle of the length of the outer margin; two short rows of fine needle-like spines run transversely across the inner aspect.



TEXT-FIG. 5.—*Cyclopina minuta*, sp. nov. *a*. Dorsal view of ♀; *b*. 1st antenna of ♀; *c*. 2nd antenna of ♀; *d*. 2nd swimming leg of ♀; *e*. 5th leg of ♀; *f*. Dorsal view of ♂.

Ovigerous females were carrying two egg-sacs each containing 6 or 7 ova.

♂: Total length 0·467 mm.

The proportional lengths of the anterior and posterior regions of the body are as 7 to 6.

As in the female, the anterior end is rounded and the cephalon is separate from the 1st thoracic segment (Text-fig. 5*f*).

The proportional lengths of the posterior regions of the body are as follows:—

Abdominal segment	1	2	3	4	5	Furca.	
	22	15	15	13	17	18	=100

Family CYCLOPIDAE.

Sub-family HALYCYCLOPINAE.

Genus **Halicyclops** Norman.

Halicyclops aequoreus Fischer.

Halicyclops magniceps, Sars, 1913-18, p. 29, pl. xv.
Halicyclops magniceps, Sewell, 1924, p. 796.
Halicyclops aequoreus, Kiefer, 1929, p. 24, fig. 9.

I recorded the presence of this species, under the name *Halicyclops magniceps*, in the Chilka Lake. Examples have been taken in the present collections in the Canal system of the Salt Lakes, Calcutta, at Chingrighatta on 19th October 1914, and at Uttarbhag (Sample 25) on 2nd January 1933.

Halicyclops propinquus Sars.

Halicyclops propinquus, Sars, 1905, p. 395, pl. xviii, figs. 135-149.

Several examples of a female *Halicyclops* that appears to agree exactly with Sars' species were taken in some of the pools at Uttarbhag (Sample 25) on 2nd January 1933.

Halicyclops tenuispina Sewell.

Halicyclops tenuispina, Sewell, 1924, p. 796, pl. xlvii, fig. 3.

This species was first described by me from the Chilka Lake. Examples have been taken in the present collections from a series of pools at Uttarbhag (Samples 23, 24 and 25) in January 1933, and also in the Canal system of the Salt Lakes at Chingrighatta on 19th October 1914.

Sub-family CYCLOPINAE.

Genus **Cyclops** Müller.

Sub-genus **Metacyclops** Kiefer.

Cyclops (Metacyclops) dengizicus Lepeschkin.

Cyclops buxtoni, Gurney, 1921, p. 840, pl. 1.
Cyclops buxtoni, Sewell, 1924, p. 798.
Cyclops dengizicus, Gurney, 1927, p. 173.
Cyclops dengizicus, Kiefer, 1929, p. 73.

A single example of this species was taken in the Salt Lakes, Calcutta. I have previously recorded its occurrence in the Chilka Lake. According to Gurney (1921, p. 840) "the second joint of the exopodite of the first leg bears 3 spines, while that of each of the three following pairs bears four." In the present example the second joint of the exopod of the 4th leg bears only three spines, two marginal and one distal.

Genus **Mesocyclops** Sars.

Sub-genus **Mesocyclops** Kiefer.

Mesocyclops (Mesocyclops) leuckarti Claus.

(Text-fig. 6, *a-k.*)

Mesocyclops obsoletus, Sars, 1913-18, p. 58, pl. xxxv.
Cyclops aspericornis, v. Daday, 1906, p. 181, pl. xiv, figs. 1-6.
Mesocyclops obsoletus, Sewell, 1924, p. 798.

This species was comparatively common in the collection. Although the general structure of this species is well known, there are a number of subspecies that have been recorded from various parts of the world and it seems advisable, therefore, to give a fairly comprehensive account of the form from the Museum Tank.

♀: Total length: this varies from 1·022 mm. to 1·289 mm.

The specimens appear at first sight to fall into two quite distinct groups according to the general shape of the body; in the first group, that are slightly less in length, the anterior region of the body is of an oval shape that agrees well with the figure given by Schmeil (*loc. cit.*, Pl. iii, fig. 1) and Sars and there is a fairly well marked line of demarcation between the anterior and posterior regions of the body. In the second group, that is slightly longer, the body is much more gradually tapered and there is less distinction in the transverse diameters of the body and tail regions, the two passing gradually into each other. I have been completely unable to detect any structural differences, sufficiently great to warrant their separation, between the two forms and this difference of shape would appear to be due entirely to the degree of contraction of the body muscles.

The proportional lengths of the anterior and posterior regions of the body are as 1·421 to 1·00 while the proportion of the cephalic segment to the whole body is as 34 to 81.

The posterior region of the body consists of five segments, of which the most anterior belongs to the thorax. The proportional lengths of the various segments of the abdomen are as follows:—

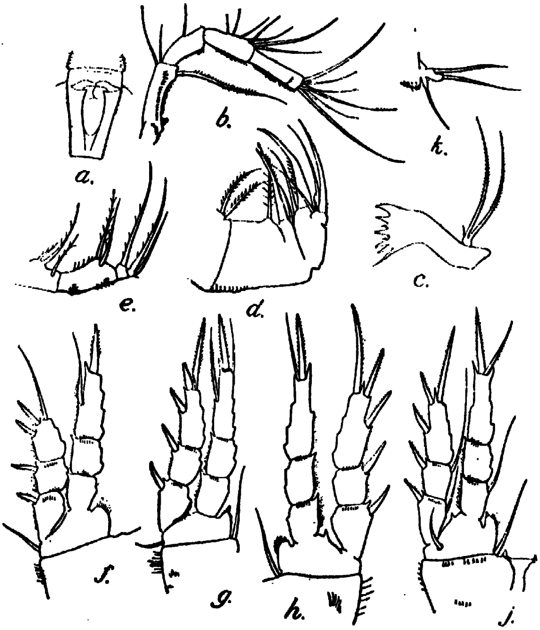
Abdominal segment .	1-2	3	4	5	Furca.	
	37	17	14	11	21	=100

The lateral regions of the 5th thoracic segment bear a number of small spines. The lateral aspect of the genital segment (Text fig. 6 *a*) is fringed with fine hairs and the posterior margin of the 5th abdominal segment, where it articulates with the furcal rami, is armed with a row of small spines.

The 1st antenna reaches back as far as the posterior margin of the 4th thoracic segment in the smaller and more rounded form, and to the posterior margin of the 3rd segment in the more elongate form. In both cases the appendage consists of seventeen free segments. The proportional lengths are as follows:—

Segment	1	2	3	4	5	6	7	8	9	
	156	42	15	71	48	23	69	33	40	
	10	11	12	13	14	15	16	17		
	42	42	54	44	42	65	111	103	=1000	

The first three segments are devoid of any spinous armature but segments 4 to 14 all carry a number of minute spines; these are arranged transversely, either in bands or lines on segments 4-6 and the proximal half of 7; on segments 7 (distal half) to 12 there is on each segment a



TEXT-FIG. 6.—*Mesocyclops* (*Mesocyclops*) *leuckarti* (claus), ♀; *a.* Genital segment of abdomen; *b.* 2nd antenna; *c.* Mandible; *d.* 2nd Maxilla; *e.* Maxilliped; *f.* 1st swimming leg; *g.* 2nd swimming leg; *h.* 3rd swimming leg; *j.* 4th swimming leg; *k.* 5th leg.

broad patch composed in the main of transverse rows of spines and a transverse row of spines along the distal margin; on segments 13 and 14 there is a longitudinal row of spines and a small transverse row along the distal margin. Segments 16 and 17 each bear a transparent lamella, that on the terminal segment showing very clearly the characteristic semilunar break in the contour. The margin of this lamella on the terminal segment is not plain, as figured by most previous workers, but is finely crenated. Schmeil (*loc. cit.* p. 63) has called attention to this feature and in his description states " der des siebzehnten dagegen ist fein gesagt und zeigt zu Beginn des letzten Drittels einen bei allen Individuen anzutreffenden brosseren Ausschnitt ".

The 2nd antenna (Text-fig. 6*b*) is long and slender. The 1st segment is armed with several rows of spines, of which three are composed of fine

needle-like spines and the fourth that runs along the lateral aspect is composed of triangular spines that increase in size distally. The 2nd and 3rd segments are both armed with a row of needle-like spines along their posterior margins. In the 4th segment there are two such rows; the proximal is by far the longer and passes along the proximal three-fourths of the posterior margin and then turns across the face of the segment in a transverse direction. The smaller distal row commences in the posterior fourth of the segment and after a short course turns across the face of the segment near the distal margin.

The labrum is bordered with a row of teeth-like processes; commencing from the outer margin of one side, there is a rounded process separated by a small gap from the others, then comes a small process that is followed by a process that is about twice the size of the others; between these two large processes are six smaller processes.

The mandible (Text-fig. 6c) closely resembles that of *Cyclops strenuus* Fischer as figured by Sars (1913-18. Pl. xvi).

The 1st maxilla is as figured.

The 2nd maxilla (Text-fig. 6d) shows an interesting difference in the two types. In the smaller form with the characteristic oval body the crenulations on the posterior margin are very inconspicuous or absent altogether, being only indicated by a series of parallel markings near the margin; in the larger and more tapering form the crenulations are present and well marked. In all other respects the appendages are identical.

The maxilliped (Text-fig. 6e) bears two patches of triangular spines on the posterior margin of the 2nd segment, as indicated by Schmeil (*loc. cit.* 1892, P. iii, fig. 4).

In the 1st swimming leg (Text-fig. 6*f*) the 1st basal bears a single inner seta and is fringed on its outer margin with a number of fine hairs. The 2nd basal segment carries an outer seta and internally is produced in a rounded lobe that is fringed with hairs; on its posterior aspect are two rows of spines, one running along the margin of the articulation with the 1st segment of the endopod and the second in a curve near the articulation of the basal segment of the exopod. Each ramus consists of three segments and the exopod only reaches as far as the level of the point of origin of the outer seta on the terminal segment of the endopod. In the exopod the segments bear 1, 1, and 2 marginal spines that, though serrated, are less strongly developed than those of the posterior pairs; the end spine is long and slender and is finely serrated along its outer margin. Exopod 1 and 2 each bear a row of small triangular spines across the posterior aspect near the articulation with the next segment. Exopod 1 is fringed along its outer margin with fine spines, while exopod 2 and the proximal part of exopod 3 are fringed with hairs.

In the 2nd swimming leg (Text-fig. 6*g*) the 1st basal segment bears two short rows of small spines on the surface near the proximal part of the outer margin, and the distal part of the margin is fringed with scattered long fine hairs. A single seta arises from the distal inner angle. The 2nd basal segment bears a single external seta and the inner margin is produced distally in a rounded eminence that is fringed with delicate

hairs. In the 1st segment of the exopod the inner margin is fringed with delicate hairs and the outer margin with minute spines; a row of small triangular spines runs across the surface near the distal margin and the margin itself is fringed with delicate hairs. The 2nd segment is also fringed along its outer margin with fine spines, and bears a row of small triangular spines across its surface distally. In the endopod both the 1st and 2nd segments bear a row of small spines across the surface near the distal margin.

The 3rd swimming leg (Text-fig. 6*h*) closely resembles the 2nd.

In the 4th swimming leg (Text-fig. 6*j*) the 1st basal segment bears a short row of small triangular spines on the proximal part of its surface, and an interrupted row near the distal margin. The 1st and 2nd segments of both the exopod and endopod bear a row of small spines near the distal margin.

The 5th leg (Text-fig. 6*k*) is of the type figured by Sars and others.

Sub-genus **Thermocyclops** Kiefer.

Mesocyclops (Thermocyclops) rylovi Smirnov.

(Text-fig. 7, *a-d*.)

Mesocyclops rylovi, Smirnov, 1929, p. 38, figs. 1-5.
Mesocyclops oithonoides, Sewell, 1924, p. 799.
Mesocyclops (Thermocyclops) rylovi, Kiefer, 1929, p. 85.

In the *oithonoides-hyalinus* group of species of the genus Mesocyclops, that Kiefer has created into a separate sub-genus *Thermocyclops*, are at least fourteen species that differ from one another only in minute details of structure.

I have carefully examined the present form and compared it with the description and figures given by previous authors. Kiefer (1929, p. 397) has stated that so far as his experience goes he has never seen *Cyclops oithonoides* in any collection from South Africa, India, the Sunda Islands and New Zealand that he has examined; in every case the species present has been either *Mesocyclops hyalinus* or some species very nearly related to it. In my account of the Copepoda of the Chilka Lake (Sewell, 1924) I recorded the presence there of *Mesocyclops oithonoides*, as I followed the nomenclature given by Sars in his account of the Crustacea of Norway (1914, p. 59) in which he gives *Mesocyclops hyalinus*, as a synonym of *M. oithonoides*. A further study of these specimens has shown that they undoubtedly belong to the *hyalinus* group.

The present form possesses the following characters:

♀: Total length about 1·0 mm.

The proportional lengths of the anterior and posterior regions of the body (Text-fig. 7 *a*) are as 1·528 to 1.

The proportional lengths of the abdominal segments are as follows:—

Abdominal segment .	1-2	3	4	5	Furca.	
	37	17	14	11	21	=100

The furcal rami are slightly divergent and are 3½ times as long as wide. The outer furcal seta arises at the junction of the middle and distal

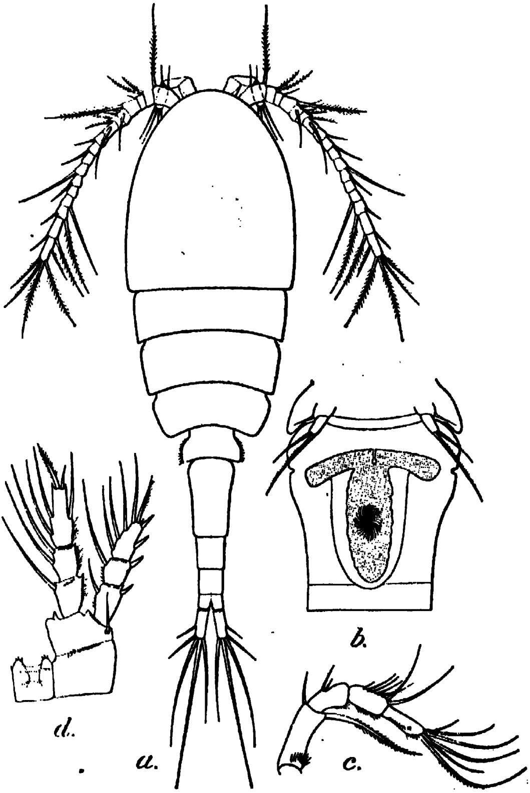
thirds of the ramus. The proportional lengths of the furcal setae are as follows :--

Seta.	1	2	3	4	5	Dorsal Accessory.
	32	57	50	13	6	15

The proportion of the 1st to the 3rd being as 1 : 1·562.

The lateral margins of the 5th thoracic segment are covered with fine hairs.

The 1st antenna consists of 17 segments of which the last bears several transverse rows of minute spinules.



TEXT-FIG. 7.—*Mesocyclops (Thermocyclops) rylovi* Smirnov, ♀; *a.* Dorsal view; *b.* ventral view of genital segment; *c.* 2nd antenna; *d.* 4th swimming leg.

The swimming legs appear to resemble exactly those of *M. rylovi*. The 1st swimming leg is comparatively robust. The connecting lamella

is provided with a rounded eminence on each side, which bears four or five small spines. The 1st basal segment bears an inner seta on a slight projection at its distal inner angle, and there is a patch of hair on the outer margin towards the proximal end. The 2nd basal segment bears an inner and an outer seta of about equal length; the rounded inner margin is fringed with hairs and there is a row of five or six small spines along the articulation for the endopod. Exopod 1 bears a single inner seta that is somewhat shorter than the inner setae of the succeeding segments. The outer margin is fringed with minute spines and a row of small spines runs across the surface parallel to the articulation with exopod 2. There is a similar row of small spines across the surface in exopod 2. All the marginal spines are subequal.

In the 4th swimming leg (Text-fig. 7*d*) the connecting plate is traversed by two rows of minute spinules and on each side there is a rounded prominence that bears three small spines. A row of spines runs along the line of articulation with basal 2. This latter segment is produced on its inner distal part in a rounded swelling that is further produced into a sharp spinous process; a row of minute spinules runs along the articulation with exopod 1 and the external marginal seta is short. In the exopod both the 1st and 2nd segments carry a row of minute spines along the articulation with the distal segment. In the endopod there is also a row of even more fine spines along the distal margins of segments 1 and 2. The two end spines are markedly unequal, though not as much so as in *Mesocyclops oithonoides*; the outer spine is slightly less than half the length of the inner.

In the 5th leg the seta on the basal segment is short and the outer seta on the free segment is considerably shorter than the inner spine.

These examples appear to agree with the form described by Smirnov under the name *Mesocyclops rylovi*. This species is widely distributed around Calcutta and occurs in samples 9, 12, 15-18, 20, 21, and 25. It has previously been recorded by me from the Chilka Lake. It appears to be an inhabitant of slightly brackish water, though occasionally occurring in water that is absolutely fresh, as the Tank in the Indian Museum.

HARPACTICOIDA.

Family ECTINOSOMIDAE.

Genus **Ectinosoma** Boeck.

Ectinosoma melaniceps Boeck.

Ectinosoma melaniceps, Sewell, 1924, p. 809.

This species was recorded by me from the Chilka Lake, so that its occurrence in the Salt Lakes, Calcutta, is not a matter for surprise. As Sars (1905, p. 380) has pointed out there is a very close resemblance between this species and the Southern form, *Ectinosoma australe* Brady (=*E. antarctica* Giesbrecht) and I am not by any means certain that these Indian examples should not be referred to the Southern form.

Family TEGASTIDAE.

Genus **Parategastes** Sars.

Parategastes sphaericus var. **similis** Sewell.

Parategastes sphaericus var. *similis*, Sewell, 1924, p. 815, pl. li, fig. 2; pl. lii, fig. 2.

A single example of what I take to be this species was found in the tow-netting from a large pool at Uttarbhag (sample 25). Up to the present time this variety has only been taken in the Chilka Lake.

Family DIOSACCIDAE.

Genus **Stenhelia** Boeck.

Stenhelia longifurca, sp. nov.

(Text-fig. 8, *a-j*).

Specimens of a *Stenhelia*, that appear to represent a new species, were taken in pools at Uttarbhag in samples 23 and 25 and one example, a female, at Chingrighatta on 19th October 1914. Several examples occurred in sample 26 from the Piali river.

♀: Total length 0·708 mm.

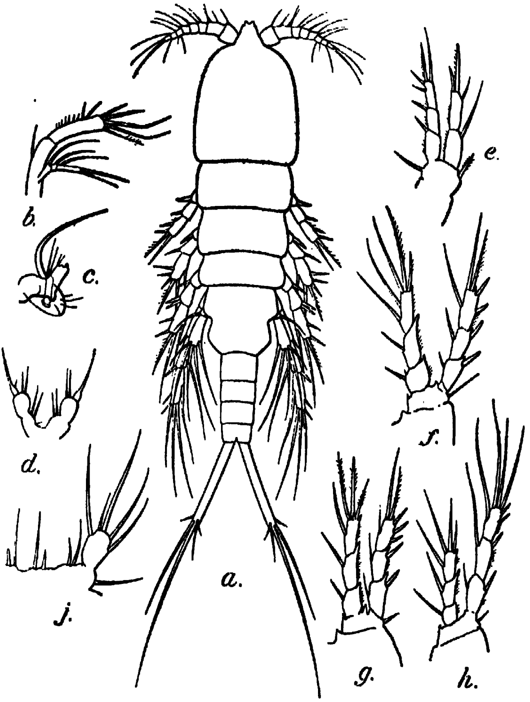
The proportional lengths of the anterior and posterior regions of the body are as 1·045 to 1. The anterior region of the body (Text-fig. 8 *a*) is comparatively robust. The cephalic segment bears anteriorly a broad rost um that terminates anteriorly in a pair of rounded protuberances. The urosome is much shorter than the anterior region of the body and is much narrower; it tapers somewhat towards the posterior end and posteriorly bears a pair of elongate and divergent furcal rami. The furcal rami are long, being almost equal in length to half the length of the abdominal segments. In its general appearance this species closely resembles *Stenheliopsis divaricata* Sars, but the structure of the appendages clearly demonstrates that it is a member of the genus *Stenhelia*.

The 1st antenna consists of 8 segments, bearing a number of setae; the appendage is short and reaches back but a little beyond the middle of th. cephalic segment.

The 2nd antenna (Text-fig. 8 *b*) possesses the structure found in other members of the genus; the two rami are markedly unequal. The outer ramus is slender and is about equal in length to the distal segment of the inner ramus; it consists of three segments, of which the middle one is small. The basal segment bears a single seta; the middle segment also carries a single seta and the terminal segment bears one seta near the base and a pair of setae arise from the distal extremity. The two segments of the inner ramus are of about equal length. The proximal segment bears a single seta on its outer margin. The distal segment bears two short spines on its anterior border, arising close together at about the junction of the middle and distal thirds of the joint, and at the distal end are two spines, two geniculate setae and a single straight seta. The anterior margin, proximal to the origin of the two spines, is armed with a row of six or seven needle-like spinules.

The mandible (Text-fig. 8c) exhibits the structure characteristic of the genus.

The 1st and 2nd maxillae are of the usual type.



TEXT-FIG. 8.—*Stenhelia longifurca*, sp. nov. ♀. *a.* Dorsal view; *b.* 2nd antenna; *c.* Mandible; *d.* Maxilliped; *e.* 1st swimming leg; *f.* 2nd swimming leg; *g.* 3rd swimming leg; *h.* 4th swimming leg; *j.* 5th leg.

The maxilliped (Text-fig. 8d) closely resembles that of *Stenhelia gibba* Boeck, as figured by Sars (1903, pl. cxix, mp_2) and of *Stenhelia inopinata* (A. Scott), as figured by me (1924), pl. liii, $2mp^3$)

In the 1st swimming leg (Text-fig. 8 *e*) the second basal segment bears a slender seta externally and a stout spine on its inner margin. The exopod consists of three segments, of which the 1st and 2nd each bear a marginal spine externally but no seta on the inner margin. The 3rd segment bears two spines on its outer margin and a spine and seta distally. The endopod consists of only two segments; the proximal bears a single seta internally and the distal segment bears one seta on its inner margin and two distally of which the inner is stout and spine-like.

The rest of the swimming legs (Text-figs. 8 *f*, *g* and *h*) all have a three-jointed exopod and endopod. In the 2nd leg the 1st basal segment is

produced at its inner distal angle in a rounded prominence. The 2nd basal segment bears a spine-like process on its inner margin and a second spine-like process is situated between the articulation of the two rami; a slender seta arises from the outer margin. In the exopod the 1st and 2nd segments each bear a single marginal spine and a slender seta arises from the inner border; this seta is especially delicate in the 1st segment. The 3rd segment carries two marginal spines and an end-spine, two setae arise from the segment, one from the inner margin and one distally. In the endopod the segments bear 1, 1, and 5 setae respectively.

The 3rd leg (Text-fig. 8*g*) resembles the 2nd, except that the 3rd segment of the exopod bears three marginal spines instead of only two and all three inner setae are delicate. The segments of the endopod bear 1, 1, and 4 setae, all of which are stout and spine-like.

In the 4th leg (Text-fig. 8*h*) the exopod is nearly twice the length of the endopod; segment 1 bears a single marginal spine and a very delicate inner seta; segment 2 bears one spine externally and a well developed seta on its inner border; segment 3 has two marginal spines and a stout end-spine, while two setae arise from the distal margin and one from the inner border. In the endopod the segments bear 1, 1, and 4 setae, all of which are stout and spine-like.

In the 5th leg (Text-fig. 8 *j*) the basal segment bears a slender seta on its outer margin and four setae arise in two pairs from the posterior border; the free segment bears five setae, of which one arises from the outer margin, three from the distal margin and one from the inner border; of the three arising from the distal margin the innermost is much smaller and more delicate than the other two.

Family CANTHOCAMPTIDAE.

Genus **Mesochra** Boeck.

Mesochra meridionalis Sars.

(Text-fig. 9, *a-f*.)

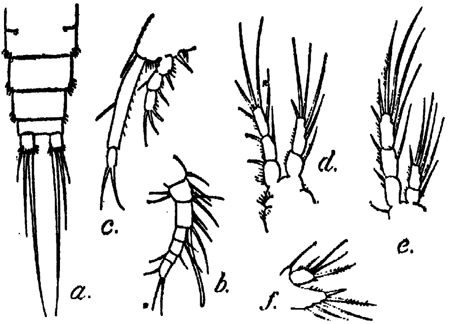
Mesochra meridionalis, Sars, 1905, p. 389, pl. XVII, figs. 87-102.

Two examples of a species of *Mesochra*, that appears to be so similar to the species described by Sars from the brackish water of Chatham Island that I have little doubt that they are the same, were taken in the Salt Lake Canal System at Chingrighatta on 19th October 1914.

♀: Total length 0·375 mm. This is somewhat smaller than Sars' examples, which measured 0·48 mm.

In the general shape and proportions of the body the present examples agree closely with Sars' description. The genital segment of the abdomen (Text-fig. 9*a*) is considerably longer than the following segments and is indistinctly subdivided near the lateral margin. The anal segment is much the shortest. The furcal rami are about as broad as long and are fringed along their distal margin with a row of delicate spines. Of the furcal setae the outer is quite small and of the two distal setae the inner is twice the length of the outer and is as long as the abdomen,

The 1st antenna (Text-fig. 9*b*) is short and is composed of seven segments, of which the proximal three are considerably stouter than the



TEXT-FIG. 9.—*Mesochra meridionalis* Sars, ♀. *a.* Dorsal view of abdominal segments; *b.* 1st antenna; *c.* 1st swimming leg; *d.* 2nd swimming leg; *e.* 4th swimming leg; *f.* 5th leg.

distal four. The 1st and 2nd segments are of about equal length and the 3rd is considerably longer. The 3rd segment bears a long sensory filament. The 2nd antenna appears to resemble the figure given by Sars (*loc. cit.*, pl. xvii, fig. 91); the 2nd segment of the endopod bears two spines on its anterior margin and a longer spine arises from the distal anterior angle, two geniculate setae and a single straight seta arise from the distal end. I was unable to see the exopod.

The mouth-parts appear to resemble the description given by Sars.

The 1st swimming leg (Text-fig. 9*c*) closely resembles that of *Mesochra meridionalis* and *M. timsae* Gurney (1927, p. 540, fig. 151, C) so far as the proportions of the endopod and exopod are concerned, but differs from both in that the 3rd segment of the exopod bears only three spines and appears to be devoid of the inner seta which in the other species arises from the distal inner angle.

The 2nd, 3rd and 4th swimming legs (Text-fig. 9 *d*, *e*) agree closely with the description given by Sars and the exopod presents the following formula :—

Exopod.

Joints	1	2	3
Leg 2	0	1	1·1·3
Leg 3	0	1	2·1·3
Leg 4	0	1	2·1·3

As Gurney has pointed out (*loc. cit.*, p. 540, 541) the form described by him under the name *Mesochra timsae* from the Suez Canal differs from *M. meridionalis*, and, therefore, from the present examples, in that the exopod of each of the swimming legs 2-4 bears four spines, three marginal and one distal, on the 3rd segment.

The 5th leg (Text-fig. 9*f*) closely resembles the description given by Sars (*loc. cit.*, p. 390 and fig. 100). The basal segment bears a fine seta

on its outer margin. The free segment is somewhat more pyriform than as figured by Sars, but the number and arrangement of the spines and setae that arise from the distal end are exactly similar. Two fine setae arise between two stout spines, of which the outer is much the shorter. The prolongation of the basal plate extends as far as or slightly further than the end of the free segment and bears five spines, of which two arise from the distal margin and three from the inner border. The innermost spine is considerably shorter than the next and is even shorter than is figured by Sars.

Although the present specimens differ in one or two small details of structure from Sars' specimens, the general resemblance is so close that I have little hesitation in referring them to the same species.

CHIROGNATHA.

Family LAOPHONTIDAE.

Genus **Laophonte** Philippi.

Laophonte bengalensis, sp. nov.

(Text-fig. 10, *a-k.*)

♀ Total length 0·563.

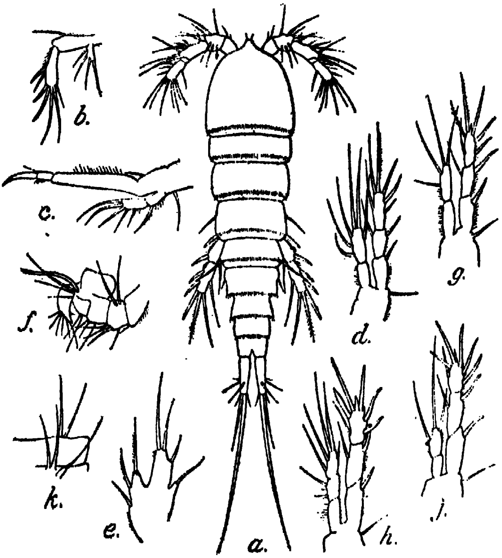
In all the specimens that I have examined the segmentation of the body is complete; there are four free thoracic segments present but the abdomen consists of four segments only.

The anterior margin of the cephalon (Text-fig. 10*a*) is rounded and bears in the middle line a somewhat truncated rostrum, that carries a pair of ext-emely small setae. The lateral margins of the thoracic segments are parallel or slightly divergent; each segment is widely separated from the segment immediately following it. The posterior thoracic margins are unarmed with rows of minute spines.

In the abdomen the 1st segment is produced into sharp points and so also is the 2nd. The anterior three segments are all provided along their posterior margins with a row of minute spinules. The anal segment narrows somewhat towards the posterior end. The furcal rami are about one-and-a-half times as long as the anal segment. The margin seta arises a little beyond the middle of the segment. Of the four distal setae the outer and inner are small, the 3rd seta is about two-and-a-half times as long as the 4th, and the 2nd seta is stout and is at least as long as the whole abdomen.

The 1st antenna consists of five segments only; of these the 1st and 2nd are of approximately equal length; the 3rd segment is the longest and is produced at its anterior distal angle in a stout process bearing a delicate seta and a sensory filament; the 4th segment is small and the line of demarcation from the 5th is not very clearly marked. The terminal segment is about as long as the third. In its general characters the antenna closely resembles the corresponding organ in *Laophonte mohammed* Guerne and Richard and *Laophonte chathamensis* Sars.

The 2nd antenna (Text-fig. 10*b*) is also very similar to this organ in the same two species. The outer ramus is short and bears four setae



TEXT-FIG. 10.—*Laophonte bengalensis*, sp. nov. *a*. Dorsal view of ♀; *b*. 2nd antenna of ♀; *c*. 1st swimming leg of ♀; *d*. 3rd swimming leg of ♀; *e*. 5th leg of ♀; *f*. Grasping antenna of ♂; *g*. 2nd swimming leg of ♂; *h*. 3rd swimming leg of ♂; *j*. 4th swimming leg of ♂; *k*. 5th leg and genital armature of ♂.

of approximately equal length. The inner ramus consists of two joints; the distal is of moderate length and bears four spines on its margin, of which the proximal two arise close together. Two geniculate setae arise from the distal end and a smaller simple seta from the distal lower angle. The inner margins of both segments are provided with a row of spines.

The mouth-parts, so far as I have been able to examine them, appear to resemble those of other members of the genus. The maxilliped bears a stout claw-like distal segment that reaches back to the end of the preceding segment.

In the 1st pair of legs (Text-fig. 10*c*) the exopod consists of only two segments and reaches to about the junction of the proximal and 2nd quarter of the length of the proximal segment of the endopod; the 1st segment carries three spines and two geniculate setae. The endopod consists of two segments of which the proximal is long, the distal segment is small and bears a stout claw-like spine.

All four pairs of swimming legs (Text-fig. 10*d*) consist of a three-jointed exopod and a two-jointed endopod. The arrangement of the

setae and spines on the various segments of the limbs is as follows :—

	Endopod.		Exopod.		
	1	2	1	2	3
P. 2	0	4	0	1	1·1·4
P. 3	0	6	0	1	1·1·4
P. 4	0	3	0	1	1·1·4

Thus in the endopod there is no seta on the 1st segment in any leg ; the second segment bears 4 setae in the 2nd leg, 6 in the third and 3 in the fourth. In the exopod the 1st segment is without a seta in all the legs ; the second segment in all bears a single seta on its inner margin and one at the distal end while in each leg there are three marginal spines and an end-spine making a total of four. There is a slight difference between this arrangement and that seen in *Laophonte chathamensis* in which the formula for the 3rd leg is

	Endopod.		Exopod.		
	1	2	1	2	3
P. 3	0	6	0	0	1·1·4

In the 5th pair of legs (Text-fig. 10*e*) the segmentation of the appendage is not complete ; the two rami being fused into a single plate. The basal portion bears three setae on its inner margin and a single seta arises from a prominence on the outer margin. The projecting portion of the appendage, that corresponds to the usual free segment, bears three setae, two from the distal end and one from the outer margin.

♂ Total length, 0·479 mm.

The general form of the body closely resembles that of the female ; there are five segments in the abdomen.

The anterior antennae (Text-fig. 10*f*) are modified into grasping organs that closely resemble those of other members of the genus.

The 3rd pair of swimming legs (Text-fig. 10*h*), as usual in this genus, differs from that of the female in that the endopod consists of three segments instead of two ; in this sex the second segment bears a single inner seta and the terminal segment carries 5. In the 3rd and 4th pairs of legs (Text-fig. 10*j*) the exopods are more stoutly developed than in the female and the terminal segment tends to bend inwards towards the middle line.

The 5th pair of legs (Text-fig. 10*k*) appears to be reduced to a small projection near the posterior margin of the segment, that bears internally two setae and at the external angle of the plate a short process from which a single seta arises. The posterior margin of the 1st abdominal segment is armed with a pair of setae.

Family CLETODIDAE.

Genus **Limnocletodes** Borutzky.

This genus was created by Borutzky (1926) to accommodate a new species that he obtained from the Volga River and its delta. Unfor-

tunately Borutzky's paper is in the Russian language; he, however, gives a summary in German and a perusal of this and a comparison of the present form with his figures leaves no doubt that in the collection from the Salt Lake system we have a second and very closely allied species to *Limnocletodes behningi* Borutzky.

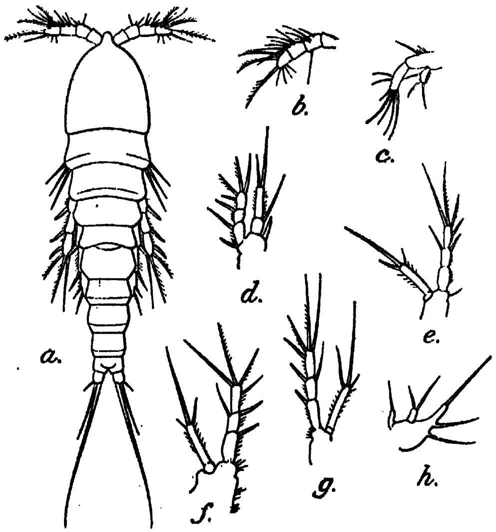
Limnocletodes secundus, sp. nov.

(Text-fig. 11, *a-h.*)

Several examples of what appears to be a new species of the genus *Limnocletodes* were taken in a shallow pool, almost dried up, alongside the road at mile 4 from Baruipur on the way to Uttarbhag (Sample 23).

♀ Total length, 0·458 mm. to 0·427 mm.

The body (Text-fig. 11*a*) is slender and tapers towards the posterior end. At the anterior end in the middle line is a small rounded rostal



Text-fig. 11.—*Limnocletodes secundus*, sp. nov. ♀. *a.* Dorsal view; *b.* 1st antenna; *c.* 2nd antenna; *d.* 1st swimming leg; *e.* 2nd swimming leg; *f.* 3rd swimming leg; *g.* 4th swimming leg; *h.* 5th leg.

projection. The genital segment is large and has the appearance of being divided into two by a tansverse suture; the furcal rami are shorter than the anal segment and bear a minute seta at the distal outer angle, while two unequal setae spring from the distal margin.

The 1st antenna (Text-fig. 11*b*) appears to consist of four segments only. The 3rd and 4th segments are thickly fringed with setae and from the terminal segment spring three comb-like setae.

The 2nd antenna (Text-fig. 11*c*) differs from that in the genus *Cletodes* in that the outer ramus is present and bears three setae.

The mouth-parts appear to be feebly developed.

The 1st swimming leg (Text-fig. 11*d*) consists of a two-jointed basal portion, a three-jointed exopod and a two-jointed endopod. The second basal segment bears a stout spine-like seta externally and a stout spine internally. Exopod 1 and 2 each bear a marginal spine, but are without an inner seta. Exopod 3 bears two marginal spines and an end-spine and a single seta arises from the distal border. The endopod is about as long as the exopod but owing to the projection of the basal segment appears to be longer; it consists of two segments, of which the proximal is comparatively stout and bears a single inner seta; the distal segment is long and cylindrical and is fringed on both borders with fine hairs; it carries two unequal setae at its distal end.

In the 2nd, 3rd and 4th swimming legs (Text-fig. 11, *e*, *f* and *g*) the structure is identical. Each appendage consists of a three-jointed exopod and a slender cylindrical endopod having two segments of which the proximal is very short. In each case the 1st segment of the exopod and the proximal segment of the endopod are devoid of setae. The distal segment of the endopod bears terminally three setae of which the inner and outer are short and the middle seta long and spine-like.

The 5th pair of legs (Text-fig. 11*h*) appears to be quite characteristic, the basal segment bears externally a single seta mounted on an elongate process; the plate itself is almost pyriform in outline and bears two setae on its inner margin and a single spine-like seta distally. The free segment is considerably reduced and bears distally two unequal setae.

An interesting feature of this species is its susceptibility to infection by a protozoan that appears to be a species of *Acineta*. At least nine out of ten examples are infected with this symbiont. In some cases the *Acineta* arose separately from a short stem, while in other instances there was a common delicate stalk from which a number of individuals arose.

Genus **Cletocamptus** Schmankewitsch.

Cletocamptus confluens (Schmeil).

Cletocamptus confluens, Gurney, 1927, p. 563, fig. 164.
Cletocamptus confluens, Borutzky, 1931, p. 88, fig. 25.

Several examples of the female of this species were taken in the Piali River.

As Gurney has pointed out, the closely allied species, *C. retrogressus* Schmankewitsch, "is a species of extreme tolerance of varying salinity, characteristic of inland pools of moderately high salinity, it has been taken in water of almost maximum density and even, as here, in almost fresh water." It would seem that *C. confluens* (Schmeil) also possesses a high degree of adaptability to varying salinity.

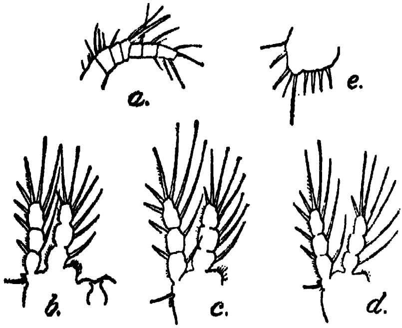
Family TACHIDIDAE.

Genus **Tachidius** Lilljeborg.

Tachidius sp.

(Text-fig. 12, *a-e.*)

A few examples of a species of *Tachidius* were taken in a road-side pool at mile 4 on the way to Uttarbhag (Sample 23). In their general structure they appear to come very near to, if they are not actually identical with, *Tachidius brevicornis.*



Text-fig. 12.—*Tachidius* sp. *a.* 1st antenna; *b.* 2nd swimming leg; *c.* 3rd swimming leg; *d.* 4th swimming leg; *e.* 5th leg.

Origin of and changes in the Copepod Fauna.

In attempting to reach any conclusions regarding the origin of the fauna of such an area as this, one must bear in mind that the presence of any given species at the present day may have been the result of passive persistence in contradistinction to active migration. In times past there can be but little doubt that this region was actually a part of the Bay of Bengal and that with the gradual extension of the Delta seawards the water of the rivers and lakes gradually became less and less salt, though the actual process must have been extremely slow. A certain number of marine species that had established themselves within the area during the early stages of the formation of the Delta would doubtless be able to acclimatise themselves to the gradually changing conditions and thus equally be able to persist in their original habitat and form a relict fauna. Annandale (1922, p. 152) has pointed out that " the number of species of marine origin that have established themselves permanently in fresh water above the limits of tidal influence in the Ganges since the old immigration of the cosmopolitan freshwater fauna is small. Most of these species belong, however, to genera no longer found in the sea and probably of relatively ancient origin. The marine fauna of the Delta, on the other hand, is rich and includes not only many peculiar genera, but others, and even species, which also live in the sea. I cannot, however, find any definite dividing line between these two faunas. The relict fauna consists merely of organisms that have proved more capable of establishing themselves in abnormal circumstances,

and, therefore, more successful in the peculiar line of life adopted by them." On the other hand a large percentage of the species that constitute the plankton may have been brought into the area by the action of the tidal currents; in many of the rivers of the Delta the flood stream is extremely powerful and in the Matla and Hooghly rivers, especially at times of spring tides, forms a "bore" that sweeps up the river carrying with it a large planktonic population. Month after month, therefore, examples of the common inhabitants of the marine littoral zone and of the lower estuarine regions will be passively swept high up the river and should they possess the necessary degree of adaptability to changes in the salinity or specific gravity of the water there seems to be but little difficulty in the way of the establishment of a permanent domicile in the higher reaches of the delta or in the associated pools and lakes.

As the deltaic region has extended seawards and the influence of the tidal flood on the salinity has become less and less, with the result that the water has become more and more fresh, a number of genera and species, whose normal habitat is fresh water, will automatically be carried into the lower reaches and through the canals into the Salt Lakes and again with but a slight degree of adaptation will be able to establish themselves in areas that only a few years ago were inhabited entirely by a brackish water or even a marine fauna.

In only a comparatively few instances does there seem to have been a definite attempt to migrate upstream from the sea into the freshwater areas above the influence of the tides; and even in these cases it is difficult to decide whether the apparent migration has been the result of the acquisition of a true anadromic habit, such as is found in some of the prawns and fish, or whether it is to be attributed to a passive distribution either of adults or of larval stages in which there was an unusual range of adaptability. In a deltaic region such as this, that is subject during the rainy season to wide-spread floods, a wide dispersal of aquatic forms is bound to occur frequently.

A comparison of the Copepod fauna of the Calcutta Salt Lakes and their associated canals and pools with that of the Chilka Lake reveals a very close agreement, especially among the Calanoida and Cyclopoida, and in the following lists I have given the different species in these two groups that have been taken in the two localities :—

Chilka Lake.

Calanoida.

Paracalanus crassirostris.
Acrocalanus inermis.
Isias tropica.
Pseudodiaptomus annandalei.
Pseudodiaptomus binghami.
Pseudodiaptomus hickmani.
Pseudodiaptomus lobipes.
Pseudodiaptomus serricaudatus.
Pseudodiaptomus tollingeri.
Diaptomus cinctus.
Diaptomus blanci.
Diaptomus contortus.
Diaptomus pulcher.
Diaptomus strigilipes.
Labidocera pavo.
Acartia chilkaensis.
Acartia centrura.
Acartia southwelli.
Acartia spinicauda.
Acartiella major.
Acartiella minor.

Cyclopoida.

Oithona brevicornis.
Oithona nana.
Cyclopina intermedia.
Cyclopina longifurca.
Halicyclops aequoreus.
Halicyclops tenuispina.
Cyclops bicolor.
Cyclops dengizicus.
Cyclops leuckarti.
Cyclops [illegible]

Hooghly River and Calcutta Salt Lakes.

Paracalanus dubia.
Acrocalanus inermis.
Pseudodiaptomus annandalei.
Pseudodiaptomus aurivillii.
Pseudodiaptomus binghami.
Pseudodiaptomus hickmani.
Pseudodiaptomus lobipes.
Pseudodiaptomus tollingeri.
Diaptomus cinctus.
Diaptomus blanci.
Diaptomus contortus.
Diaptomus orientalis.
Diaptomus strigilipes.
Diaptomus viduus.
Labidocera gangetica.
Pontella andersoni.
Acartia chilkaensis.
Acartia plumosa.
Acartia spinicauda.
Acartiella major.
Acartiella tortaniformis.
Oithona brevicornis.
Oithona horai.
Cyclopina longifurca.
Cyclopina minuta.
Halicyclops aequoreus.
Halicyclops propinquus.
Halicyclops tenuispina.
Cyclops dengizicus.
Cyclops leuckarti.
Cyclops rylovi.

Thus out of thirty species recorded from the Salt Lake System twenty, or 67 per cent., have been taken in the Chilka Lake. A number of species have been taken in the Chilka Lake that have not so far been detected in the Calcutta Salt Lake system and I give a list of these below :—

Paracalanus crassirostris
Isias tropica
Diaptomus pulcher
Labidocera pavo
Acartia centrura
Acartia southwelli
Acartiella minor
Oithona nana
Cyclopina intermedia
Cyclops bicolor

Of these no less than nine are marine forms that undoubtedly are able to make their way into the Chilka Lake through the very short entrance channel, through which at certain seasons of the year there is a strong inflowing current that will naturally assist the entrance of such forms. It is hardly a matter for surprise that such forms should be absent from the Salt Lake system, and especially from that area of it that we have examined for the distance from the sea proper is in the neighbourhood of some ninety miles in the straight line and very considerably more through the tortuous windings of the river and nullah connections. Furthermore, in the Chilka Lake the salinity of the water during the hot months of the year and especially in the proximity of the entrance channel is but little less than that of salt water, whereas in the Salt Lake Canal system the salinity, so far as we have evidence, is now but little above that of fresh-water and never remotely approaches that of salt water.

A study of the distribution of the planktonic fauna of the Salt Lake system reveals several interesting features. In the Hooghly River above the level of Howrah Bridge we got a number of species that we may definitely consider to be true fresh-water forms, since all observations on the salinity of the water in this area have shown that it is completely fresh and, although within the limit of influence of the tides, since there

is a regular tidal rise and fall accompanied by a complete reversal of the flow, is yet so far removed from the sea that salt-water cannot penetrate sufficiently far up the river to affect the salinity of the water.

In this area we get the following species :—

Copepoda :—

Diaptomus blanci.
Diaptomus cinctus.
Diaptomus contortus.
Diaptomus indicus.
Diaptomus orientalis.
Diaptomus strigilipes.
Diaptomus viduus.
Pseudodiaptomus lobipes.
Acartia (Acartiella) tortaniformis.
Mesocyclops (Mesocyclops) leuckarti.
Cyclopina minuta.

Cladocera :—

Ceriodaphnia rigaudi.
Diaphanosoma excisum var. *longiremis.*
Moina dubia.

On the other hand we find in the Salt Lakes and associated pools and canals a number of species that must equally definitely be considered to be normal inhabitants of brackish-water. Species that I class in this group are the following :—

Pseudodiaptomus annandalei.
Pseudodiaptomus binghami.
Pseudodiaptomus hickmani.
Pseudodiaptomus tollingeri.
Acartia chilkaensis.
Acartia plumosa.
Acartia (Acartiella) major.
Oithona horai.
Halicyclops aequoreus.
Halicyclops propinquis.
Halicyclops tenuispina.
Cyclopina longifurca.
Cyclops dengizicus.
Mesocyclops (Thermocyclops) rylovi.

and possibly in the same category should be placed

Paracalanus dubia.
Acrocalanus inermis.
Laophonte bengalensis.
Stenhelia longifurca.
Parategastes sphaericus var. *similis.*
Limnocletodes secundus.

Associated with these latter species, especially in the lower reaches of the canals and rivers, we may get an admixture of species that are definitely marine in their origin, though they may now be undergoing acclimatisation and be establishing a habitat in brackish-water areas, such as :—

Pseudodiaptomus aurivillii.
Acartia spinicauda.
Labiodocera gangetica.
Pontella andersoni.
Oithona brevicornis.

As we pass from the fresh water of the river system along the canals of the Salt Lakes we get a gradual change in the composition of the planktonic fauna, although there is little or no accompanying change in the specific gravity of the water. This change is particularly well seen in the catches made at four stations on the Canal system on the 28th and 29th of December, 1932, and in the accompanying table I have tabulated the results obtained, commening with station 17 which is furthest removed from the Hooghly river and working nearer through stations 16 and 15.

Species.	Sample. 17 28th December 1932.	16 28th December 1932.	15 28th December 1932.	14 29th December 1932.
Diaptomus contortus	—	—	—	+
Diaptomus cinctus	—	+	+	+
Pseudodiaptomus annandalei	+	+	+	—
Pseudodiaptomus tollingeri	+	—	—	—
Acartia (Acartiella) tortaniformis	+	—	—	—
Acartia chilkaensis	+	+	—	—
Mesocyclops ryloni	+	+	+	—
Mesocyclops leuckarti	—	—	—	+
Moina dubia.	+	+	++	++
Brachionus pala	—	+	++	+++
Brachionus bakeri var. *latissimus*	—	+	++	+

— absent.
\+ present.
++ common.
+++ in enormous numbers

In sample 17, although the salinity of the water was only 2·03 per mille, we find a typical brackish-water fauna, including two species of *Pseudodiaptomus*, two species of *Acartia* and the brackish-water Cyclops, *Mesocyclops* (*Thermocyclops*) *rylovi*; we also get the Cladoceran *Moina dubia* but no other fresh-water form. As we pass to sample 16 one species of *Pseudodiaptomus*, *P. tollingeri*, disappears, as well as one species of *Acartia*, *Acartia* (*Acartiella*) *tortaniformis;* and one species of fresh-water copepod, *Diaptomus cinctus*, and two species of Rotifers, *Brachionus pala* and *B. bakeri* var. *latissimus*, make their appearance although the salinity is actually slightly higher than in the former locality, namely 2·41 per mille. In sample 15 the second species of *Acartia*, *A. chilkaensis*, has disappeared and the Cladoceran, *Moina dubia*, and the two species of Rotifers have become more numerous, though the salinity is actually higher than in the more distant station, being still 2·20 per mille. Finally, as we come to Sample 14, from the canal near Chingrighatta which, though no nearer to the Hooghly river than the locality from which sample 15 was taken, is now completely cut off from the canal system that connects with the Bidyadhari river, we get the disappearance of the second species of *Pseudodiaptomus*, *P. annandalei*, and of the brackish-water inhabiting *Mesocyclops* (*Thermocyclops*) *rylovi*, and the appearance of two more fresh-water inhabiting forms, namely *Diaptomus contortus* and *Mesocyclops* (*Mesocyclops*) *leuckarti*. In this last locality the salinity had fallen to 1·19 per mille.

I have already pointed out that changes have been taking place in past years in the character of certain of the canals owing to silting up, and associated with this there has been a very interesting change or series of changes in the character of the fauna. In 1908 Annandale called attention to the presence in brackish-water pools at Port Canning of the Medusa, *Campanulina ceylonensis* (Browne), and in 1912 (*Rec. Ind. Mus.*, Vol. XII) the same species was discovered in large numbers in the Canals of the Salt Lake system. In 1926 the Zoological Survey party found the medusa still present in the Kristopur Canal but during the past few months no sign of its presence has been detected in any tow-netting from the canals either in this part or in any other: this may be due to the fact that it is not the proper season for it, but it appears not improbable that with the lowering of the salinity of the water it has died out owing to the changed conditions since, as Annandale noted (*vide supra* p. 57), it is killed off when the salinity falls below 1006. Another change that has taken place between 1926 and the present day in the plankton of the western portion of the Kristopur Canal is indicated by the comparison of two tow-nettings from the same locality. In the earlier one taken in 1926—the whole catch consisted of a pure culture of *Pseudodiaptomus annandalei*, which as I have indicated, is a brackish-water form; but in 1932 a tow-netting in the same area contained, in addition to *Pesudodiaptomus annandalei*, examples of *Acartia chilkaensis* and *Mesocyclops* (*Thermocyclops*) *rylovi*, which I regard as brackish-water forms, and specimens of *Diaptomus cinctus*, which is definitely a fresh-water form. This gradual change in the plankton is still more clearly brought out by a comparison of three tow-nettings which I am fortunate enough to have before me, and which

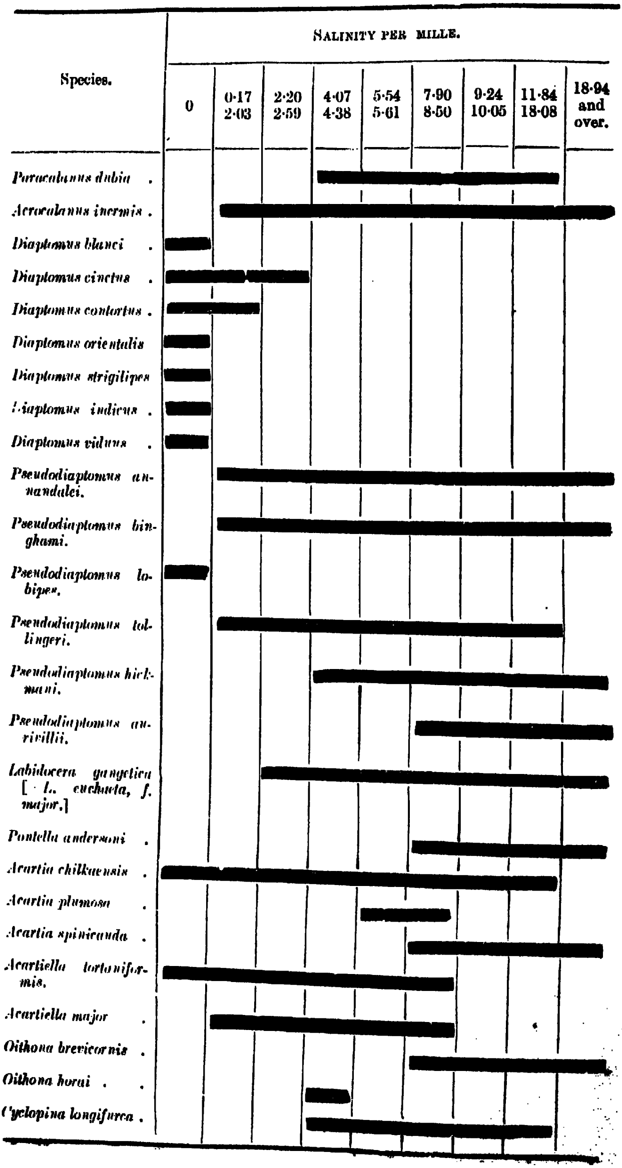
were taken in 1914, 1930 and 1932 respectively; the composition of these tow-nettings is given below:—

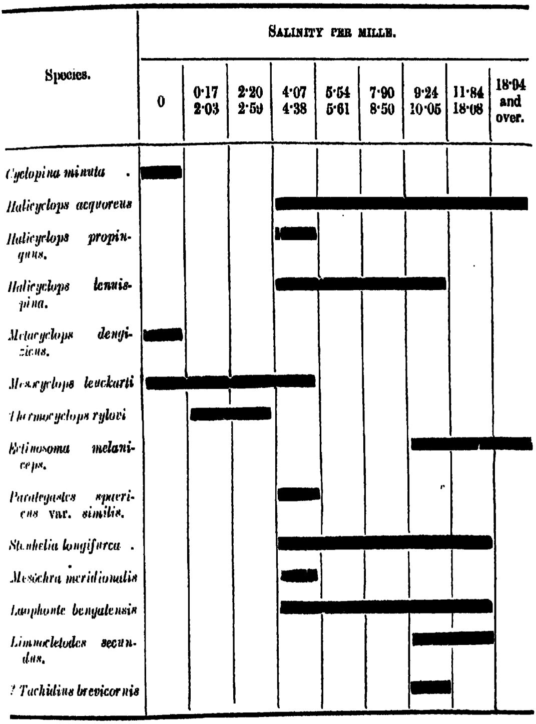
Station—Chingrighatta—Dhappa Canal.

Species.	19th October 1914.	20th October 1930.	29th December 1932.
Diaptomus contortus	+	+	+
Diaptomus cinctus	—	—	+
Pseudodiaptomus annandalei	+	+	—
Pseudodiaptomus binghami	+	+	
Pseudodiaptomus tollingeri	+	—	
Acartia chilkaensis	+	+	—
Acartia plumosus	+	—	—
Acartia (Acartiella) tortaniformis	+	—	—
Oithona brevicornis	+	—	—
Cyclopina longifurca	+	—	—
Halicyclops aequoreus	+	—	—
Halicyclops tenuispina	+	—	—
Mesocyclops (Mesocyclops) leuckarti	+	+	+
Mesocyclops (Thermocyclops) rylovi	+	—	—
Mesochra meridionalis	+	—	—
Laophonte bengalensis	+	—	—
Stenhelia longifurca	+	—	—

From this we see that in 1914, out of a total of 16 species of Copepoda 14 definitely belong to the group of brackish-water forms and 2 to fresh-water species, these latter being *Diaptomus contortus* and *Mesocyclops (Mesocyclops) leuckarti*. By 1930, 11 of these brackish-water species had disappeared from the locality leaving only three of the more adaptable forms, namely *Pseudodiaptomus annandalei*, *P. binghami* and *Acartia chilkaensis*. Finally in 1932 these three brackish-water forms have now disappeared and an additional fresh-water species of Copepod, namely *Diaptomus cinctus*, has made its appearance, as well as enormous numbers of the Rotifer *Brachionus pala*. Unfortunately I have no record of the salinity of the water in the two earlier observations, but there can be but little doubt that the water was originally markedly brackish and in 1922 the specific gravity was high as 1006·0—1008·5 (*vide supra*, p. 59) whereas at the present time it is as low as 1000·9 (Salinity 1·19).

In the following table I have attempted to indicate, so far as our knowledge at present extends, the range of salinity within which each species in the collection can exist. In a number of instances and especially in the case of new species our knowledge is admittedly incomplete and further researches may greatly increase the range of salinity that such species can tolerate.


Species.
SALINITY PER MILLE.
0
0·17 2·03
2·20 2·59
4·07 4·38
5·54 5·61
7·90 8·50
9·24 10·05
11·84 18·08
18·94 and over.
Paracalanus dubia
Acrocalanus inermis
Diaptomus blanci
Diaptomus cinctus
Diaptomus contortus
Diaptomus orientalis
Diaptomus strigilipes
Diaptomus indicus
Diaptomus viduus
Pseudodiaptomus annandalei.
Pseudodiaptomus binghami.
Pseudodiaptomus lobipes.
Pseudodiaptomus tollingeri.
Pseudodiaptomus hickmani.
Pseudodiaptomus aurivillii.
Labidocera gangetica [= L. euchaeta, f. major.]
Pontella andersoni
Acartia chilkaensis
Acartia plumosa
Acartia spinicauda
Acartiella tortaniformis.
Acartiella major
Oithona brevicornis
Oithona horai
Cyclopina longifurca



In the family Paracalanidae examples of both *Paracalanus* and *Acrocalanus* occur in brackish water. In the former genus Dahl (1893) recorded the occurrence of *Paracalanus crassirostris* from the delta of the Amazon River in water that showed a salinity of 11·8-12·8 per mille. T. Scott (1894) recorded the presence of *Paracalanus pygmaeus* (Claus) from the Gaboon River and Banana Creek, Congo River, in West Africa. Subsequently it was pointed out by Giesbrecht and Schmeil that the species with which T. Scott was dealing was not *Paracalanus pygmaeus* (Claus), but was probably *Paracalanus crassirostris* Dahl. In 1912 I described a form of *Paracalanus*, under the name *P. dubia*, from the mouth of the Rangoon River in water the density of which was 1002. In 1924 I further pointed out that it was possible that all three forms might be representatives of the same species, and Früchtl (1924) in the same year reached the same conclusion and termed *Paracalanus crassirostris* Dahl from the Amazon River forma *typica*, the form described by T. Scott from the mouth of the Congo river as forma *scotti* and *Paracalanus dubia* mihi from the mouth of the Rangoon River as forma *sewelli*. Without accepting this terminology, it is certain that all three

forms are closely related to each other and I am inclined to believe that the form described by T. Scott from the mouth of the Congo River may be the same as the form that I have called *Paracalanus dubia*; but I consider that *Paracalanus crassirostris* Dahl is in all probability a different species. Be that as it may, it is interesting to note that the form of *Paracalanus* found in the Hooghly River is the same as that found in the mouth of the Rangoon River but differs from that present in the Chilka Lake. The specific gravity of the water in which *Paracalanus crassirostris* Dahl (*sensu stricto*) has been taken ranges from 1028·5 to 1001·93, which corresponds to a range of salinity from 37·94 to 3·59. *Paracalanus dubia* Sewell has up to the present time only been taken within a range of salinity of 4·07 to 12·30.

Acrocalanus inermis Sewell appears to be more tolerant of low salinity and has been taken in water with as low a salinity as 0·17, though never in absolutely fresh water.

It seems probable that both these species, namely *Paracalanus dubia* and *Acrocalanus inermis*, should be regarded as examples of a relict (marine) fauna, that has been left behind and has gradually become acclimatised to life in only slightly brackish water.

In the case of the genus *Pseudodiaptomus* there can be but little doubt that the estuarine region of the Gangetic Delta is one extremely favourable for existence and at the same time, from its wide variations in salinity, temperature and other conditions, is one in which the evolution of new species would be stimulated. In the Indian region the known distribution of the species of this genus is as follows:—

(*a*) Forms known only from the sea:—

Pseudodiaptomus clevei A. Scott.
Pseudodiaptomus burckhardti Sewell.
Pseudodiaptomus salinus Giesbrecht.
Pseudodiaptomus masoni Sewell.

(*b*) Forms known from estuarine and brackish water, as well as from the sea:—

Pseudodiaptomus aurivillii Cleve.
Pseudodiaptomus mertoni Früchtl.
Pseudodiaptomus serricaudatus (T. Scott).

(*c*) Forms known from estuarine and brackish water:—

Pseudodiaptomus annandalei Sewell.
Pseudodiaptomus binghami Sewell.
Pseudodiaptomus dauglishi Sewell.
Pseudodiaptomus hickmani Sewell.
Pseudodiaptomus tollingeri Sewell.

(*d*) Forms known from fresh water only:—

Pseudodiaptomus lobipes Gurney.

In a widely-distributed genus such as this the question naturally has arisen, whether migration has been from the sea into fresh water or *vice versa* or again whether the genus may not have arisen in brackish water and have migrated equally in both directions. Tollinger (1911)

and Burckhardt (1913) have both studied this problem in the Diaptomidae and they have reached the conclusion that in the genus *Pseudodiaptomus* migration must have been from the sea through the brackish water areas into pure fresh water. Furthermore, this migration must have been carried out independently in both eastern and western hemispheres, and in the former from the Atlantic on the west coast of Africa, from the Indian Ocean, where it has given rise to *Pseudodiaptomus lobipes* Gurney, and from the Pacific Ocean, where it has caused the appearance of *Pseudodiaptomus forbesi* Poppe, *P. inopinus* Burckhardt, and *P. japonicus* Kikuchi. Burckhardt (1913, p. 392) has given a geneological tree of the relationships of various species of this genus and in this he shows the close relationship between *Pseudodiaptomus lobipes, P. poppei, P. forbesi* and *P. opinus.* Stillman Wright (1928, p. 596) points out that " by modifying the conformation of the tree somewhat, the species described since 1913 can be placed in their proper places. It is obvious that *P. tollingeri* should be placed near *P. poppei. P. smithi* may be placed on a branch coming off between the last two species, while a form similar to *P. smithi* may be considered ancestral to *P. forbesi* and *P. inopinus.* While *P. annandalei* cannot be properly considered a member of the group, it has certain characters which indicate that it may have a common ancestor with the group members." Gurney (1927, p. 140) on the other hand would appear to have reached the conclusion that the migration of the various species of the genus has been from fresh to salt water; he remarks that "*Pseudodiaptomus salinus* belongs to a genus which is characteristic of fresh-water or of estuarine regions where salinity is low. Yet here we have a species living in Suez Bay (not in the sea to the South) and able to establish itself in the very high salinity of the Bitter Lakes." The view that this genus is characteristic of fresh water is contrary to all the evidence and I entirely agree with Burckhardt that the genus is of marine origin and that there has been and doubtless still is a tendency towards migration into brackish and on into fresh water, though but few species have actually been able to penetrate beyond the brackish-water regions.

Among the Pontellidae, in the genus *Labidocera* the majority of species are definitely marine in their habitat, but a few have become acclimatised to life in brackish waters. *Labidocera lubbocki* Giesbrecht was recorded by Lubbock under the name *L. darwinii*, from the mouth of the Guayaquil River and T. Scott under the same name, *L. darwinii*, described a form from the Gaboon River in West Africa; this latter species was subsequently named *L. scotti* by Giesbrecht. *Labidocera fluviatilis* Dahl occurs in the estuary of the Amazon in water having a salinity ranging from 11·8 to 12·8 per mille. *Labidocera euchaeta* which was described by Giesbrecht from the Straits of Formosa, has frequently been taken in Indian waters and appears to be "essentially a brackish-water inhabitant and occurs in the estuarine regions of most, if not all, of the main rivers" (Sewell, 1932, p. 360) and in the case of the Rangoon River, where it was common, the salinity was only 3 per mille. In the present collection adult examples, as well as numerous young stages, of *Labidocera gangetica* were taken in a tow-netting in Diamond Harbour on the Hooghly River, in water that has a salinity of

only 7·90 to 8·50 and young stages were obtained as high up as Achipur in water of a salinity of only 2·23. It thus seems clear that there is a distinct tendency for examples of this genus to extend their habitat upstream in most, if not in all, of the large rivers of the world.

The genus *Pontella* is almost entirely marine in its habitat. One species, *Pontella gaboonensis* T. Scott, was taken in the tow-net at the mouth of the Gaboon River, Africa, and in the present collections examples of *Pontella andersoni* Sewell were captured in Diamond Harbour, Hooghly River, in water having a salinity of 7·90 to 8·50. This latter species has previously been taken off Chittagong and in the vicinity of the Tavoy River and in the Mergui Archipelago, but never previously in water of so low a salinity.

In the family Acartiidae, the genus *Acartia* is for the most part essentially marine in its habitat; but there is a distinct tendency, especially well marked in the sub-genus *Acartiella*, for certain species to migrate into brackish water, or even into water that is absolutely fresh. In the sub-genus *Acartiura*, *Acartia* (*Acartiura*) *clausi* var. *gaboonensis* T. Scott was found living in the Gaboon River on the west coast of Africa, but, as the specific gravity of the water in which the variety was taken was as high as 1023·01, it can hardly be considered to be a true brackish-water form. *Acartia* (*Acartiura*) *simplex* Sars, however, appears to have definitely established itself in brackish water in Chatham Island in the Pacific Ocean; this species is very closely related to *Acartia* (*Acartiura*) *ensifera* Brady that is known from New Zealand and it is possible that the one has been evolved from the other or that both may have had a common ancestor. In the sub-genus *Acanthacartia* we find a tendency for certain species to be present in brackish-water areas. *Acartia* (*Acanthacartia*) *chilkaensis* Sewell and *A*. (*A*). *plumosa* T. Scott have both been taken in such a habitat. The latter was recorded by T. Scott from Loanda Harbour in the Gulf of Guinea on the west coast of Africa and in Banana Creek, Congo River, in water that had a specific gravity of 1008·7 and in the present paper I have recorded its presence in the Salt Lakes, Calcutta, in water of a specific gravity of only 1004·6 (Salinity 5·81). *A*. (*A*.) *chilkaensis* Sewell was first recorded from the Chilka Lake from water the density of which ranged, according to Kemp, from 997·5 at 28·6° C to 1003·25; since then examples have been taken in the canals of the Salt Lakes, Calcutta, in which this species appears to be a permanent inhabitant, where the specific gravity ranges from 1014·52 (Salinity 18·08) to 1001·43 (Salinity 1·87), and in the Hooghly River, where the water was absolutely fresh. Again, in the sub-genus *Odontacartia* we have two species that are capable of maintaining their existence in water that is brackish. *Acartia* (*Odontacartia*) *centrura* Giesbrecht, which is normally an inhabitant of salt-water, has been taken in the Chilka Lake (Sewell, 1924) in water the density of which ranged from 1027·0 to 1014·5; and *A*. (*O*.) *spinicauda* Giesbrecht, which is also normally an inhabitant of salt water, has been taken in the Chilka Lake in water the density of which ranged from 1010·0 to 1015·0 at 15° C, and a single specimen occurred in the Salt Lake Canal system at Chingrighatta in 1914, when the general facies of the fauna was essentially of a brackish-water type; unfortunately I have no record of the

actual specific gravity of the water here at that time and in more recent years there have been considerable changes, but it was then about 1006·0 to 1008·5. Numerous examples occur in the Hooghly River at Diamond Harbour, where the water has a specific gravity of 1006·3 to 1006·8 (Salinity 7·9-8·5).

In the sub-genus *Acartiella* the only species that has up to the present time been taken in the sea is *Acartia* (*Acartiella*) *kempi* Sewell, all the other species having been taken in brackish water and in the case of *Acartia* (*Acartiella*) *tortaniformis* Sewell in actually fresh water. There can be little doubt that the genus, and especially the sub-genus *Acartiella* is gradually making its way into the fresh waters of India and I have in a previous paper (Sewell, 1919, p. 17) called attention to the structural changes that are being undergone and that appear to be correlated with the change in habitat.

In the Cyclopoida it is but natural to expect a very considerable degree of tolerance to brackish and even fresh-water conditions. Commencing with the Family Oithonidae, sub-family Oithoninae, there are several species of the genus *Oithona* that exhibit such a tolerance. I have in a previous paper (Sewell, 1924) recorded the presence of *Oithona brevicornis* Giesbrecht and *Oithona nana* Giesbrecht from the Chilka Lake; the former was taken in water the density of which ranged from 1015·0 at 15° C. to 1003·25, while the latter appears to have been rather less tolerant and occurred in water with a density ranging from 1026·0 to only 1006. This latter species has not, so far, been recognised in the collections from the Salt Lakes and their associated waters but a species that appears to be new and to which I have given the name *horai* was found in the collections from Uttarbhag in water the specific gravity of which ranged from 1003·47 (Salinity 4·38) to 1003·29 (Salinity 4·16), while *Oithona brevicornis* has been taken in brackish water of a specific gravity of about 1006-1008·5 at Chingrighatta in 1914, and in both the Hooghly and Piali Rivers in water having a specific gravity of 1006·3-1006·8 (Salinity 7·90-8·50) and 1014·5 (Salinity 18·08) respectively. On the Atlantic coasts *Oithona minuta* T. Scott has been taken in brackish water in Banana Creek, Congo River, in water having a specific gravity of 1008·7, while *Oithona amazonica* Burckhardt, as its name implies, was taken in freshwater in the Amazon River. Burckhardt (1913) has also described a new species belonging to a closely related genus *Limnoithona*, namely *L. sinensis*, from fresh water from the Tai-hu and Yangtze Kiang Rivers, China. This latter genus has since been transferred by Kiefer (1929) to a new sub-family Limnoithoninae. Burckhardt (1913, p. 444) claims that the occurrence of these species indicates that, although the native habitat of the genus is the sea, where the majority of species are found, certain species are at the present day attempting to migrate into fresh water and that whereas *Oithona minuta* has only proceeded a little way in this migration and is still for the most part to be found in salt water, *Oithona amazonica* has penetrated entirely or almost entirely into fresh water and *Limnoithona sinensis* completely so. Rosendorn (1927, p. 55) is, however, unwilling to accept this explanation and points out that certain species, namely *Oithona nana*, *O. simplex*, *O. minuta* and

O. brevicornis are all marine and brackish-water forms, and maintains that this is not due to any tendency to actual migration into fresh water but merely to a degree of adaptability that enables them to inhabit either type of locality. The occurrence of *Oithona horai* in the Salt Lakes seems to me, however, to be in favour of Burckhardt's view that there is in certain species or group of species in this genus a distinct trend towards migration into a fresh-water habitat, accompanied by definite structural changes.

In the family Cyclopinidae the great majority of species of the genus *Cyclopina* are inhabitants of salt water and most of the species have been reported from the northern Atlantic or its offshoots, as the following list clearly shows :—

Cyclopina longifurcata Scott . .	North Sea.
Cyclopina longicornis Boeck . .	North Sea.
Cyclopina littoralis Brady . .	British Coasts.
Cyclopina dilatata Sars . . .	Coast of Norway.
Cyclopina pygmaea Sars . .	South and South-west coasts of Norway.
Cyclopina brachystylis Sars . .	South and South-west coasts of Norway.
Cyclopina norvegica Boeck . .	North Sea and Baltic.
Cyclopina elegans T. Scott . .	Firth of Forth, Norwegian Coast and Gulf of Naples.
Cyclopina gracilis Claus . .	Arctic Seas, the North Sea, Mediterranean Sea and Suez Canal.
Cyclopina schneideri T. Scott . .	Around the Lofoten Islands.
Cyclopina steueri Früchtl . .	Mediterranean Sea and in the Aru Archipelago, Malay Straits.
Cyclopina belgica Giesbrecht . .	In the Antarctic seas between Lat. 70 and 71 S.

In a previous paper (Sewell, 1924) I recorded the presence of two species of this genus in the fresh or brackish waters of the Chilka Lake, namely *Cyclopina longifurca* and *C. intermedia*, and Sars (1905) has recorded *Cyclopina pusilla* from brackish water in Chatham Island in the Pacific Ocean. *Cyclopina intermedia* was taken in water that was absolutely fresh, but *C. longifurca* exhibits a wide range of tolerance, for it has now been taken in the water of the Chilka Lake that had a density of only 997·0 at 31·5° C, in the Salt Lake Canal system of Calcutta in water the specific gravity of which ranges from 1003·29 to 1007·40 (Salinity 4·16 to 9·24), and, at the other end of the scale, in weed washings from the sea at Tuticorin. The occurrence of yet another species, *Cyclopina minuta*, sp. nov., in water that was absolutely fresh, indicates that in this genus also there is a distinct tendency to spread inland into fresh-water areas.

In the genus *Halicyclops* only one species, namely *H. aequoreus* (Fischer) has up to the present time been found living in the sea and even in this species individuals have equally been taken in brackish and even in fresh water, or in inland salt-water lakes, etc. Burckhardt (1913, p. 456-7) has called attention to the close relationship between this genus and *Cyclops fimbriatus* and, if I understand him aright, he is of the opinion that *Halicyclops* has evolved from the genus *Cyclops* (*sensu lato*) and that it is now in the process of migrating from fresh to brackish or even to salt water.

The Harpacticidae have up to the present time received but little attention in India and in consequence we are still extremely ignorant both as regards the various species that inhabit Indian waters and their natural habitat. A number of species were taken in the Chilka Lake (*vide* Sewell, 1924) and many of these in water that was brackish, but with the exception of the two species, *Ectinosoma melaniceps* Boeck and *Parategastes sphaericus* var. *similis* Sewell, the Harpacticids taken in the Salt Lakes, Calcutta, and the associated water-ways belong to different species. Chappuis (1928) has given an account of several species of Harpacticids that were taken in fresh water, but again none of these species occur in the Salt Lake collections. It is, therefore, impossible to form any very definite opinion regarding the origin of the Harpacticid fauna of the Gangetic delta. In the Family Canthocamptidae several members of the genus *Canthocamptus* have been described from India (*vide* Chappuis, 1928) from fresh water. In this family numerous species, belonging to several genera, have succeeded in establishing themselves in a fresh-water habitat and in the genus *Mesochra* species are known to occur in either salt or brackish water, at least one species having been found occasionally in water that is actually fresh. According to Gurney (1920, p. 358) *Mesochra rapiens* (Schmeil) [=*M. hirticornis* (T. Scott)] is normally found in brackish water and always not far from the sea; it has, however, been taken in absolutely fresh water in the Ekoln branch of Lake Malaren, that is considered to be the remains of a former extension of the Baltic, and its presence in this latter region suggests that it is to be regarded as a part of a relict fauna. In the present collections *Mesochra meridionalis* Sars has been found in the Salt Lake Canal system and its presence in two such widely separated localities as this and Chatham Island in the Pacific Ocean strongly suggests that in each case it is to be regarded as a relict, that has been left behind in the Salt Lakes as the deltaic area gradually extended further seawards.

Among the Laophontidae, two species belonging to the genus *Laophonte*, namely *L. chathamensis* and *L. quinquespinosa*, occur in the Chilka Lake. Of these the former had already been taken in brackish water in Chatham Island in the Pacific Ocean and in the Chilka Lake both occurred in water that had a specific gravity of 1002. In the Salt Lakes a new species, *Laophonte bengalensis*, has been taken in water having a specific gravity ranging from 1003·29 to 1014·52 (Salinity 4·16 to 18·08); but since at least one species, namely *L. mohammed*, is known to have established itself in fresh water, it is not possible to form an opinion as to whether these Indian species should be regarded as euryhaline species that have invaded this area from the sea or as marine relicts that have been able to survive the gradual diminution in the salinity of the water, or even casual visitors swept in by the flood tide.

The family Cletodidae includes a number of genera that between them exhibit a wide range of habitat but which are almost entirely marine. A certain number of species, belonging to the genera *Cletocamptus*, *Nannopus* and *Enhydrosoma* have established themselves in fresh water and in 1926 Borutzky created another genus, *Limnocletodes*, in this family to accommodate a species that he had taken in the Volga River.

The occurrence of a second species in this new genus in the delta of the Ganges is of considerable interest, but at the present time we do not know enough about its distribution to be able to determine the range of salinity in which it can exist or to form an opinion as to whether it normally inhabits brackish water. The occurrence of *Stenhelia longifurca*, sp. nov. and *Laophonte bengalensis*, sp. nov. in the Piali River and the adjoining pools at Uttarbhag, as well as in the Chingrighatta-Dhappa Canal before the Central Lake channel silted up and Dhappa Lock was closed, indicates that these species have in all probability been carried into these pools and canals from the river during periods of flood tides, and the same is probably true of *Limnocletodes secundus*.

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NOTES ON FISHES IN THE INDIAN MUSEUM.

XXII. On a Collection of Fish from the S. Shan States and the Pegu Yomas, Burma.

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At the request of one of us Mr. V. P. Sondhi of the Geological Survey of India made a small collection of fish in Burma during the field-season of 1932-33. A part of Mr. Sondhi's material was obtained in the Southern Shan States to the east of Taunggyi, but not very far from it; and the remainder from the western drainage of the Pegu Yomas. Both the areas are hilly tracts and the collection was made in small torrential streams with a rocky bed. Such streams are characterised by rapids and slow currents with pools and back-waters here and there. Some of the streams are diverted for the irrigation of "paddy" fields, and in the Southern Shan States the water is usually charged with lime to such an extent that it forms travertine dams causing small falls. Mr. Sondhi informs us that the structure of the country in the regions traversed by him is of a nature similar to that described by Annandale[1] in his account of the Inlé Lake.

The fish fauna of Burma is not well known, and our knowledge of the smaller forms, specially those inhabiting brooks, is still very imperfect. Mr. Sondhi's collection, therefore, though small, both in the number of species and individuals, is full of interesting forms, and, with its help, it has been possible to elucidate several problems of taxonomic importance. We give below a list of localities with the names of the species of fish collected therefrom.

Southern Shan States (December, 1932-April, 1933).

1. A small stream flowing out of a spring at Repiu, north of Loi-un about 6 miles from Hopong.

   i. *Lepidocephalichthys berdmorei* (Blyth) . . . . 6 specimens.
   ii. *Ophicephalus gachua* Ham. Buch. . . . . . 3 specimens.

2. A small stream at Kyouksu, 1½ miles east of Repiu.

   i. *Barbus hexastichus* McClelland . . . . 1 specimen.
   ii. *Danio (Danio) aequipinnatus* (McClelland) . . 1 specimen.

3. Stream below the bridge to the east of Hopong Rest House.

   i. *Barbus hexastichus* McClelland . . . 3 specimens.
   ii. *Barbus sarana caudimarginatus* Blyth . . . 1 specimen.
   iii. *Nemachilus rivulicola* Hora . . . . . 10 specimens.

4. Spring at mile 15¾ east of Taunggyi and 3½ miles east of Hopong.

   i. *Barbus sarana sewelli* Prashad and Mukerji . . 1 specimen.
   ii. *Danio (Brachydanio) shanensis* Hora . . . 9 specimens.
   iii. *Danio (Brachydanio) sondhii*, sp. nov. . . . 11 specimens.

[1] Annandale, *Rec. Ind. Mus.*, XIV, pp. 4-6 (1918).

5. Stream to the west of the village of Hopong.

i. *Barbus sarana caudimarginatus* Blyth	4 specimens.

6. Tank at Pangtara.

i. *Barbus sarana caudimarginatus* Blyth . . .	1 specimen.
ii. *Ophicephalus gachua* Ham. Buch. . . .	1 specimen.

7. Canal issuing from a stream to the south-west of Lawksawk.

i. *Danio (Danio) aequipinnatus* (McClelland) . .	2 specimens.
ii. *Nemachilus rivulicola* Hora	3 specimens.

Pegu Yomas (May, 1933).

Gyobyu Chaung, west of the new dam line, western drainage of the Pegu Yomas.

i. *Amblyceps mangois* (Ham. Buch.) . . .	1 specimen.
ii. *Clarias batrachus* (Linn.)	1 specimen.
iii. *Aoria bleekeri* (Day)	2 specimens.
iv. *Barbus sarana caudimarginatus* Blyth . . .	1 specimen.
v. *Danio (Danio) annandalei* Chaudhuri . . .	1 specimen.
vi. *Nemachilus multifasciatus* (Day) Vincig. . .	1 specimen.
vii. *Acanthopsis choirorhynchus* (Bleeker) . . .	1 specimen.
viii. *Ophicephalus gachua* Ham. Buch. . . .	1 specimen.
ix. *Mastacembelus armatus* (Lacépède) . . .	1 specimen.
x. *Ambassis ranga* (Ham. Buch.) . . .	2 specimens.

The collection from the Pegu Yomas was made in one place by putting a dam across a small stream and allowing the bed below the dam to run dry. The fishes were picked up afterwards from underneath stones and boulders or from crevices.

In the collection dealt with here there are, as detailed above, 69 specimens, of which 57 were collected in the S. S. States area. These 57 specimens comprise representatives of 9 species and varieties, while the remaining 12 specimens from the Pegu Yomas represent 10 species. With the exception of *Barbus sarana caudimarginatus* Blyth, an endemic Burmese race of the widely distributed species, and *Ophicephalus gachua* Ham. Buch., no other species or variety is common to the two lots. The species collected in the Pegu Yomas, with the exception of *Danio annandalei* and *Acanthopsis choirorhynchus*, are fairly widely distributed both in Burma and India. Even *D. annandalei* and *A. choirorhynchus* are not endemic in the Pegu Yomas, the former was described from the base of the Dawna Hills, whereas the latter is known from Sumatra, Java, Malay Peninsula, Burma and Annam. Among the species obtained by Mr. Sondhi in the S. S. States, half the number is endemic to that region. *Danio (Brachydanio) sondhii* is a new species described here for the first time, while *Danio (Brachydanio) shanensis*, *Barbus sarana sewelli* and *Nemachilus rivulicola* are only known from the Shan States or adjacent parts of Burma.

In the following account keys are given to the species of *Danio* and *Brachydanio*. Besides the description of the new species of *Brachydanio*, the precise specific limits of *D. annandalei* are discussed and defined. From a study of extensive material it is concluded that both *Barbus caudimarginatus* Blyth and *Barbus sewelli* Prashad and Mukerji should

be regarded as varieties or subspecies of the widely distributed Indian form, *Barbus sarana.* It is also indicated that *Ophicephalus harcourt-butleri* Annandale[1] cannot be considered a distinct species from the widely distributed and variable *O. gachua.* Attention is also directed to an abnormal specimen of this species in which both the ventral fins are absent, but the basipterygia are only slightly deformed. This abnormality raises the question of the validity of the generic names *Channa* and *Ophicephalus,* but a consideration of this problem is left over for some future occasion. Further light is thrown on the variation exhibited by the Burmese and Siamese specimens of *Amblyceps mangois.*

Mr. Sondhi's collection has added materially to our knowledge of the fishes of Burma. It has to be remembered, however, that the collection seems to have been made in the steadier portions of the streams, and not in the course of very swift currents. Most of the forms represented here live in small pools or in back-waters in the course of hill streams. *Amblyceps* and *Nemachilus* are the only two genera, the members of which are found among pebbles at the bottom of small streams, but some specimens are likely to stray into pools.

We take this opportunity to offer our sincerest thanks to Mr. V. P. Sondhi for affording us an opportunity to study such an interesting material. Mr. Sondhi's observations on the colouration of living specimens have been most helpful and are published here with due acknowledgment. To Dr. B. Prashad we are indebted for going through the manuscript. Mr. R. Bagchi made the drawings with his usual skill and care under our supervision and for this our thanks are due to him.

Clarias batrachus (Linn.).

1913. *Clarias batrachus,* Weber and Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 190, fig. 74.

There is a young specimen of *Clarias batrachus* from the Pegu Yomas in Mr. Sondhi's collection.

Aoria bleekeri (Day).

1890. *Macrones bleekeri,* Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova,* (2), IX, p. 91.

There are two fine specimens of *Aoria bleekeri* in Mr. Sondhi's collection. They were obtained by him from the Pegu Yomas, and exhibit the colouration characteristic of the Burmese examples of the species.

Amblyceps mangois (Ham. Buch.).

1933. *Amblyceps mangois,* Hora, *Rec. Ind. Mus.,* XXXV, pp. 607-621.

Mr. Sondhi collected one young specimen of *Amblyceps mangois* in the Pegu Yomas. One of us (Hora, *op. cit.*) has so recently dealt with the classification, bionomics and evolution of the fishes of this genus that we need not refer in detail to the characteristics of the species. It

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[1] Annandale, *Rec. Ind. Mus.,* XIV, pp. 54, 55, pl. ii, fig. 7, pl. iv, figs. 16, 17 (1918).

may be mentioned, however, that in the specimen under report the caudal fin is deeply forked and the lobes are pointed, but are not drawn out into thread-like processes as is the case in most of the Siamese examples. The adipose fin is long and well developed. The caudal peduncle is almost as high as long. The barbels are longer than those of the Indo-Burmese specimens and in this respect the specimen agrees with the Siamese examples. The modification of the gill-opening is intermediate between the Siamese and Indo-Burmese forms. Though the species is widely known from N. India, Burma and Siam, it has been recorded only once before by Vinciguerra[1] from Lower Burma.

Since the publication of the revision of the genus by one of us, more material from Siam (19 specimens: 16 from Pak Jong, 2 from Nakon Sritamarat and 1 from Chantabun Estuary) has become available for study through the kindness of Dr. H. M. Smith. An examination of this material has shown that in the main the Siamese specimens agree with the description already given. In some examples the lobes of the caudal fin are not drawn out into thread-like processes. The adipose dorsal also exhibits a certain amount of variation. Similarly the structure of the gill-opening and the associated parts is also subject to variation. On account of these variations it is not proposed to separate the Siamese form into a separate race or a subspecies.

Barbus sarana (Ham. Buch.).

1822. *Cyprinus sarana*, Hamilton Buchanan, *Fish, Ganges*, pp. 307-310.

Barbus sarana belongs to a group of species in which there are four barbles and the last undivided dorsal ray is osseous and serrated. The serrated spine is deeply grooved along the entire posterior border; the serrations are short and are situated along the two edges of the groove. The species is widely distributed in India, Burma and Ceylon, and the colouration is uniform with the exception of the Burmese specimen in which the caudal fin sometimes has a black upper and lower edge and a dark mark at the base of each scale. These gorgeously coloured, Burmese specimens were described by Blyth[2] as ***Barbus caudimarginatus***, but Annandale[3] regarded it as a Burmese race of the typical ***B. sarana***, and later workers[4] have agreed with Annandale's conclusion. Recently Prashad and Mukerji[5] described a still more gorgeously coloured species from Northern Burma as *Barbus sewelli*, but an examination of the material in the Indian Museum has convinced us that it should also be regarded as a local race of the typical form quite distinct from ***caudiamarginatus***.

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[1] Vinciguerra (*Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, p. 68, 1890) recorded a single specimen from "Meetan"—lat. 16°.

[2] Blyth, *Journ. Asiat. Soc. Bengal*, XXIX, p. 157 (1860).

[3] Annandale, *Rec. Ind. Mus.*, XIV, p. 46, pl. iii, fig. 3 (1918).

[4] Hora, *Rec. Ind. Mus.*, XXII, p. 183 (1921); Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 199 (1929).

Hora pointed out that Annandale was not justified in regarding *Barbus oatesii* Boulenger (*Ann. Mag. Nat. Hist.*, (6), XII, p. 201, 1893) as synonymous with *Barbus sarana caudimarginatus*.

[5] Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 197, pl. ix, figs. 1, 1*a*, 1*b*, (1929).

It would thus appear that *Barbus sarana*, a very common carp of Indian waters, has proliferated into two subspecies in Burmese waters. It is well known that several plain-looking species of India are marked with brilliant colour bands or marks in Burma. In the case of *caudimarginatus* and *sewelli*, besides the colouration, some other structural modifications have also taken place. In typical *sarana* of India, there are 32-34 scales along the lateral line and 3½-4½ scales in a transverse series. In *caudimarginatus* there are only 28-30 scales along the lateral line and 4½ scales in a transverse series. Apart from the well marked difference in colouration, *sewelli* differs from both typical *sarana* and *caudimarginatus* in having a proportionately longer head, bigger eyes and somewhat narrower caudal peduncle. The number of scales along the lateral line is 32-34 and in a transverse series 4½. Of the two Burmese races of *B. sarana*, *caudimarginatus* is widely distributed, having been recorded from both Upper and Lower Burma, whereas *sewelli* has only been found in the Shan States so far.

In Mr. Sondhi's collection there are seven specimens of *B. sarana caudimarginatus*, and these were obtained from the following localities :—

i. One young specimen from Hopong, S. S. States.
ii. Five half-grown specimens from a stream to the west of the village of Hopong, S. S. States.
iii. One half-grown specimen from the western drainage of the Pegu Yomas.

Of *Barbus sarana sewelli* only one specimen, 78 mm. in length without the caudal, was collected by Mr. Sondhi from a spring at 15¾ miles east of Taunggyi and about 3½ miles east of Hopong. The subspecies is recorded here from the S. Shan States for the first time.

Barbus hexastichus McClelland.

1929. *Barbus hexastichus*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, pp 200, 201, fig. 7.

Barbus hexastichus is represented in Mr. Sondhi's collection by four specimens. Of these, three young specimens, not exceeding 32 mm. in length without the caudal, were collected under the bridge near the Hopong Rest House. The following note on the colouration of the living specimens was made by Mr. Sondhi :

"Light brown and greenish iridescent. White metallic lustre near the eyes and upon the gill-covers. A prominent black round spot at the base of the caudal fin."

The fourth specimen is 73 mm. in length without the caudal and was obtained at Kyouksu, about 1½ miles east of Repiu. "When fresh, it was light brown in colour with a light iridescent, ill-defined band along the sides." The species is known as "*Pa-mong*" among the Shan people.

The young specimens of this species are liable to be confused with those of *B. sarana caudimarginatus* which also have a black spot at the root of the caudal fin. The species can be readily distinguished by the nature of the dorsal spine which is smooth in *hexastichus* and denticulated in *caudimarginatus*.

Danio (Brachydanio) shanensis Hora.

1928. *Danio (Brachydanio) shanensis*, Hora, *Rec. Ind. Mus.*, XXX, p. 38, fig. 1.

Danio (*Brachydanio*) *shanensis* is represented in the collection by nine specimens which were obtained on the 27th December, 1932, from a spring about 15¾ miles east of Taunggyi or about 3½ miles east of Hopong. "The spring is perennial and must be rich in lime as it issues from limestone." These specimens are from 34 to 49 mm. in length without the caudal. Mr. Sondhi observed two colour forms in this lot. In one set of 5 specimens he found "a white metallic patch upon the gill-cover. A bluish iridescent line begins at the tail-end and ends about the middle of the body in a sharp point." In the remaining 4 specimens, which are somewhat larger in size, "the side band is made of alternate spots of dark and light towards the posterior half of the body. The darker patches are green-iridescent and lighter ones show golden colours. They tend to expand and become less defined towards the head."

The species was originally described from the Northern Shan States where it is quite common in rice fields, in pools and ditches in the bed of hill streams at Namkhan, Kutkai, Lashio and Hsipaw. Its range of distribution is extended here to the Southern Shan States.

The specimens on which the original description was based were up to 38 mm. in length excluding the caudal fin. The great variation in colouration exhibited by the species has already been indicated by one of us, and Mr. Sondhi's observations on the colouration of the species recorded above in the living specimens point to the same conclusion. Juvenile specimens are silvery, later a broad lateral band of dark colour appears which is broader anteriorly. With the growth of the fish, the anterior half of the band is broken up into a number of vertical bars with lighter spaces in between and ultimately only the narrow posterior half of the band persists.

In the specimens from the S. Shan States, the lateral line is very variable. In most of the specimens it is incomplete, terminating above or slightly behind the anal fin. In one of the specimens it is interrupted above the anal fin over three scales, but then it bends upwards and is continued to the middle of the root of the caudal fin.

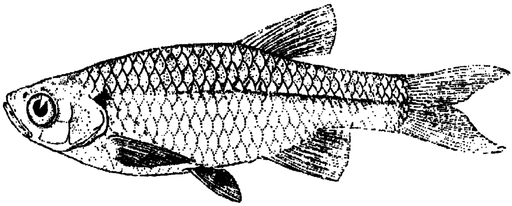
Danio (Brachydanio) sondhii, sp. nov.

D. 2/7 : A. 2/10 ; P. 1/12-13 ; V. 1/7 ; C. 19 ; L 1. 32-34 ; L. tr. 7.

With a number of specimens of the preceding species, Mr. Sondhi obtained 11 specimens of a small species of *Brachydanio*, which appears to be new to science. We have great pleasure in associating the name of this beautiful, small species with that of Mr. V. P. Sondhi. The new species may be characterised as follows :

In *Danio* (*Brachydanio*) *sondhii* the dorsal profile rises gently from the tip of the snout to the origin of the dorsal fin beyond which it slopes down to the root of the caudal fin. The ventral profile is bow-shaped. The fish is greatly compressed from side to side, specially in the posterior half, and the abdominal edge is fairly sharp. The head is small and pointed ; its length is contained from 3·6 to 4·0 times in the total length

without the caudal. The greatest width of the head is contained from 1·6 to 1·8 times and its height at occiput 1·3 times in its length. The eyes are large, dorso-lateral in position and visible from the ventral surface. The diameter of the eye is greater than the length of the snout and the interorbital width; it is contained from 2·8 to 3·2 times in the length of the head. The eye is situated almost entirely in the anterior half of the head. The interorbital space is almost flat or slightly convex.



Text-fig. 1.—Lateral view of the type-specimen of *Danio* (*Brachydanio*) *sondhii*, sp. nov. × 2¼.

The mouth is directed obliquely upwards and the maxillary extends below the anterior border of the eye. Barbels are absent. No pores are noticeable on any part of the head. The depth of the body is somewhat greater than the length of the head and is contained from 3·4 to 3·7 times in the total length without the caudal. The scales are thin and firmly adherent to the body; those on the dorsal surface are fairly conspicuous, but those on the lower half of the fish are hardly distinguishable. There are 32 to 34 scales in a longitudinal series and 7 rows in a transverse series. There are 15 predorsal scales. There is a short fleshy appendage in the axil of the pectoral fin, and a thin scaly sheath at the base of the anal and caudal fins. The lateral line pierces only 8 to 10 anterior scales and is totally absent in the posterior region.

The dorsal fin commences almost in the middle of the body without the head, and its origin is 3 scales anterior to that of the anal fin; it contains two spines and seven branched rays and its height is almost equal to or slightly less than the length of the head. The pectoral fin is long and pointed; it is as long as or slightly shorter than the head and extends to the base of the ventral fin. The ventral is similar to the pectoral but is considerably shorter; it just reaches or misses the anal-opening which is situated just anterior to the anal fin. The anal fin is similar to the dorsal but it is not so deep; it is separated from the caudal fin by a considerable distance. The depth of the caudal peduncle is almost two-thirds of its length. The caudal fin is almost as long as the head; it is deeply furcate with equal pointed lobes.

Mr. Sondhi observed that in life this species is somewhat darker in colour than *D. shanensis*. The iridescent lateral band is a little broader but less defined and almost indistinguishable in the anterior part of the body. The most characteristic feature of this species is the presence of a dark spot near the upper angle of the gill-opening. The eyes are slightly metallic green in life.

In spirit specimens the edges of the scales on the back are provided with small, dark spots, whereas the sides are lightly or heavily infuscated

with small black dots. The nape is provided with a dark patch and in young specimens there is a narrow, dark band along the dorsal surface. The fins are without any colour markings.

Measurements in millimetres.

Total length without caudal	37·0	33·0	32·0	30·0	28·0
Depth of body	10·0	9·5	8·5	8·0	7·5
Length of head	9·5	9·0	8·0	8·0	7·0
Width of head	5·5	5·0	5·0	4·5	4·0
Height of head at occiput	7·0	6·5	6·0	6·0	5·5
Length of snout	2·0	1·75	1·75	1·5	1·5
Diameter of eye	3·0	3·0	2·75	2·5	2·5
Interorbital width	2·5	2·5	2·5	2·25	2·0
Longest ray of dorsal	9·0	8·5	7·5	7·5	7·25
Length of pectoral	9·0	8·0	8·0	7·0	7·0
Length of ventral	6·0	5·5	5·5	5·5	5·0
Longest ray of anal	8·0	7·5	7·0	6·5	6·0
Length of caudal peduncle	6·0	6·0	5·5	5·5	5·5
Least height of caudal peduncle	4·5	4·0	4·0	4·0	3·75

Remarks.—In 1916, Weber and Beaufort[1] divided the fishes of the genus *Danio* into two subgenera as follows :—

"*a. Danio* s. str. Dorsal fin elongate, with 12-16 branched rays. Lateral line complete. Continental Asia, Ceylon.

b. Brachydanio subg. n. Dorsal fin short, with 7 branched rays only. Lateral line incomplete or absent."

During recent years several new forms of the *Brachydanio*-type have been discovered in Burma and though in all of them the dorsal fin is short, the lateral line has been found to be very variable. In the majority of forms it is either absent or extends over a few scales in the anterior region ; but there are some species in which it is fairly extensive or even complete. These small, gorgeously coloured fishes are usually found in great abundance in suitable localities and seem to be perfectly adapted for aquarium life. The Indo-Burmese species of the subgenus *Brachydanio* may be distinguished by the following key :—

Artificial key to the species of the subgenus *Brachydanio*.

I. Lateral line complete or rudimentary.

A. Lateral line complete or at least extending beyond anal fin. (Barbels absent or represented by a short maxillary pair) ; L. l. 34 . . . . . . *shanensis* Hora.

B. Lateral line incomplete, not extending to anal fin.

1. Lateral line extending beyond pectoral fin, but not reaching base of ventral. (Two pairs of well-developed barbels) ; L. l. 31-33 . . . *albolineatus* (Blyth) (=*analipunctatus* Blgr.).

2. Lateral line short, not extending beyond pectoral fin.

a. Two pairs of well-developed barbels (L. l. 28-30 ; body and caudal fin marked with four metallic blue bands) . . . . . . *rerio* (Ham. Buch.).[2]

[1] Weber and Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 85 (1916).

[2] Lateral line is very variable in *D.* (*Brachydanio*) *rerio* as indicated in the remarks below the key.

b. Barbels absent.

i. L. 1. 32-34; a well-defined black mark near upper angle of gill-opening . . . . *sondhii*, sp. nov.

ii. L. 1. 30; black mark near upper angle of gill-opening absent . . . . . . *acuticephala* Hora.

II. Lateral line totally absent.

A. Two pairs of barbels.

1. Maxillary barbels extending nearly to middle of pectoral (L. 1. 28-30) . . . . . . *rerio* (Ham. Buch.).

2. Maxillary barbels shorter than head (L. 1. 33) . *choprae* Hora.

B. One pair of maxillary barbels (L. 1. 30-32) . . *nigrifasciatus* (Day).

Remarks.—All the species of *Brachydanio* described so far are very characteristic, not only with regard to the characters enumerated in the above key but also in their colouration. The colour markings of the various species appear to be specific.

Attention may here be directed to the fact that in *Danio* (*Brachydanio*) *rerio* the lateral line is very variable. Prashad and Mukerji[1] have already shown that in this species the lateral line may be distinct, piercing 2-6 anterior scales, rudimentary or totally absent. In some Burmese examples they found this structure better developed, reaching as far as the base of the ventral fin. It is due to the variation of this character that the species is included under both the main sections of the key. Apart from any other consideration, *D. rerio* can be distinguished most readily by its prominent and well marked colour bands.

Danio (Danio) aequipinnatus (McClelland).

1929. *Danio aequipinnatus*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, pp. 205, 206.

Mr. Sondhi's collection contains three specimens of *Danio aequipinnatus*, a widely distributed and beautiful species of the fresh waters of India and Burma. One of these was obtained in December, 1932, at Kyouksu, a village about 1½ miles east of Repiu and, when alive, was brownish in colour with " a well-defined strong band of dark blue along the sides and both above and below it are thinner-golden bands. The blue band runs along the entire length from tail to head and breaks up in a wavy line before reaching the gill-opening." The species is known as " *Nga-chhikha* " at Kyouksu, and is considered to be a larvicidal fish.

The other two specimens were collected in April, 1933, in the clear spring water of the Lawksawk Canal near the Rest House. The colouration of the smaller specimen was similar to that described above, whereas in the larger example the central blue band is broken up into three bands separated by golden lines. " The uppermost golden line is wavy but continuous, and the colour band just underneath it is greenish blue. A faint golden line extends through it for about half of its length. The lower golden line is straight and continuous."

It may not be out of place to mention here that one of us[2] has already remarked on the validity of Regan's *Danio browni*[3] from Upper Burma.

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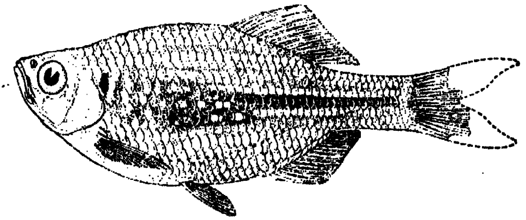
[1] Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 206-208, pl. vii, fig. 5 (1929).
[2] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, 1934 (in press).
[3] Regan, *Rec. Ind. Mus.*, I, p. 395 (1907).

The four typical specimens on which the description is based are preserved in the collection of the Zoological Survey of India. They are all young and agree in almost every respect with the young specimens of *Danio aequipinnatus*. We are, therefore, of opinion that *D. browni* cannot be regarded as a distinct species.

Danio (Danio) annandalei Chaudhuri.

1908. *Danio annandalei*, Chaudhuri, *Rec. Ind. Mus.*, II, pp. 125, 126.
1924. *Danio annandalei*, Myers, *Amer. Mus. Novitates*, No. 150, p. 2.

In Mr. Sondhi's collection there is a single specimen which, after a careful study, we have referred to *Danio annandalei*, a gorgeously coloured small fish described by Chaudhuri from a jungle stream near Kawkareik, at the base of the Dawna Hills in Tenasserim, Lower Burma. Chaudhuri gave a detailed description of the colour-pattern of the species which is not very different from that of *Danio dangila*. Superficially the two species appear identical, but they are easily distinguished by well-marked diagnostic characters. In discussing the affinities of *D. annandalei*, Chaudhuri attached considerable importance to the presence or absence of scaly or fleshy appendages at the bases of the paired fins, for he observed "Besides other apparent and conspicuous differences the new species differs from *D. spinosus* in possessing appendants to the pectoral fins (whereas *D. spinosus* has none), and from *D. dangila*, which possesses appendants to the ventral fins." Our observations on the various species of the genus show that in almost every case a scaly appendage is present above the base of the ventral fin and a fleshy appendage in the axil of the pectoral fin.



TEXT-FIG. 2.—Lateral view of a type-specimen of *Danio* (*Danio*) *annandalei* Chaudhuri × 1½.

Mr. Sondhi's specimen is 58 mm. in total length without the caudal, and was taken in the western drainage of the Pegu Yomas (Gyobyu Chaung). The brilliant colour-pattern has faded away entirely, though with proper illumination four or five round, whitish markings could be made out. In every other respect, this specimen agrees with the two typical examples in our collection and with Chaudhuri's description of the species. As no figure of the species has so far been published, we give above a lateral view drawing of one of the type-specimens.

With the specimens of *D. annandalei*, several examples of *D. dangila* and *D.* (*Brachydanio*) *albolineatus* were collected by Dr. N. Annandale. We have indicated above that *D. annandalei* and *D. dangila* appear to

be similar superficially, but the salient characters tabulated below will help to distinguish the two species. We also give here a table of measurements of three specimens of each species to facilitate detailed comparison in future.

Danio annandalei.	*Danio dangila.*
1. Both pairs of barbels less than diameter of eye.	1. Both pairs of barbels at least as long as thrice diameter of eye.
2. L. tr. 15 (11½/3½).	2. L. tr. 9 (6½/2½).
3. Length of snout contained 4 times in length of head.	3. Length of snout contained 4·8-5·5 times in length of head.

Measurements in millimetres.

	D. annandalei.			*D. dangila.*		
	Upper Burma.	Dawna Hills Types.		Dawna Hills.		
Total length without caudal	58·0	55·0	56·0	61·0	57·0	45·0
Length of head	14·0	14·0	14·0	14·5	12·5	11·0
Depth of body	19·0	19·5	20·0	19·5	17·0	15·0
Width of head	8·0	8·0	8·0	9·5	8·0	6·0
Height of head at occiput	10·5	11·0	11·0	10·0	10·0	8·0
Length of snout	3·5	3·5	3·5	3·0	2·5	2·0
Diameter of eye	4·0	4·5	4·5	4·0	4·0	3·25
Interorbital width	4·0	4·0	4·5	4·5	4·0	3·0
Longest ray of dorsal	8·5	9·0	10·0	12·0	12·0	7·5
Length of pectoral	13·5	12·5	13·0	14·0	14·0	11·0
Length of ventral	8·0	8·0	8·0	10·0	9·5	6·5
Length of base of anal	12·0	11·0	11·0	12·0	11·0	9·5
Length of caudal peduncle	9·0	10·0	10·0	10·5	10·0	7·5
Least height of caudal peduncle	7·0	6·5	7·0	8·0	7·5	5·5

In 1924, Myers[1] described a new species of *Danio, D. strigillifer*, from Burma and gave a key to all the species of the genus *Danio*, s. str. On an examination of a large collection of Danios from India, Burma and Siam in the Indian Museum, we have found it necessary to include here an emended key of the various species. Unlike members of the subgenus *Brachydanio*, these fishes are somewhat more difficult to define, particularly as the colour-pattern is common to several of them, and the range of variation of other diagnostic features of the various species is considerable.

Artificial Key to the species of the subgenus *Danio*.

I. One or two spines along anterior margin of orbit below nostrils. [Two pairs of barbels; L. l. 33-38; L. tr. 15 (12½/2½)] . . . . *spinosus* (Day).

II. Spines along anterior margin of orbit absent.

- A. Barbels absent [L. l. 33-38; L. tr. 15 (12½/2½)] . *devario* (Ham. Buch.).
- B. Barbels present.
  - 1. A pair of short rostral barbels; maxillary barbels, if present, rudimentary.
    - *a.* L. l. 32; L. tr. 11. ("A dark line along the middle of the sides through the tail, with occasionally obscure dusky bands above and below it.") . *kakhienensis* Anderson.

[1] Myers, *Amer. Mus. Novitates*, No. 150, p. 2 (1924).

b. L. l. 35-37; L. tr. 9 (6½/2½). ("A badly marked broad, steel-blue stripe, extends from behind the eye to the caudal fin, while it is bounded above and below by a narrow yellow edging") . . . *neilgherriensis* (Day).

2. Two pairs of well developed barbels.

a. A well-defined black mark near upper angle of gill-opening.

i. Lateral bands breaking up anteriorly to form a mottled pattern.

α. Both pairs of barbels much longer than diameter of eye [L. l. 36-42; L. tr. 9 (6½/2½)] . . . *dangila* (Ham. Buch.).

β. Both pairs of barbels equal to or shorter than diameter of eye.

*L. l. 37; L. tr. 10 (7½/2½). . . . . *strigillifer* Myers.

**L. l. 42-46; L. tr. 15 (11½/3½) . . . *annandalei* Chaudhuri.

ii. Lateral bands not breaking up anteriorly to form a mottled pattern.

α. Several well marked and uniform lateral bands [D. 3/9-12; L. l. 34-36; L. tr. 10 or 11 (7½/2½ or 8½/2½)] . . . . *aequipinnatus* (McClell.) (= *browni* Regan).

β. Single lateral band well marked posteriorly [D. 3/8; L. l. 38-40; L. tr. 11 (8½/2½)] . . *naganensis* Chaudhuri.

b. Black mark near upper angle of gill-opening absent [middle rays of caudal fin black; barbels minute; L. l. 32-34; L. tr. 11 (8½/2½)] . . . *malabaricus* (Jerdon).

It was pointed out by Myers (*op. cit.*) that *Danio chrysops* (Cuv. and Val.)[1] is perhaps not a *Danio*, as in this species the anal fin is stated to be entirely behind the dorsal whereas in *Danio* the hinder half of the dorsal fin is at least situated above the anal fin. We consider the position of the dorsal with relation to that of the anal a fundamental character and on this account do not regard *D. chrysops* to be congeneric with the other species. Unfortunately, from the meagre information available, it is not possible to discuss the exact systematic position of *D. chrysops*.

With the exception of *D. kakhiensis*[2] and *D. strigillifer*, we have examined the types, topotypes or a good series of specimens of all the other species.

Nemachilus rivulicola Hora.

1929. *Nemachilus rivulicola*, Hora, *Rec. Ind. Mus.*, XXXI, p. 324, pl. xv, figs. 3 and 4.

Nemachilus rivulicola was described by one of us from the clear, rocky streams in the Yawnghwe Valley and the He-Ho plain. Mr. Sondhi obtained 10 specimens from underneath the bridge near the Hopong Rest House and 3 more examples from a canal near Lawksawk Rest House. It thus appears that the species is fairly widely distributed in the Southern Shan States. The specimens in Mr. Sondhi's collection agree in almost every detail with those in the type series.

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[1] Cuvier and Valenciennes, *Hist. Nat. Poissons*, XVII, p. 308 (1844); Day, *Fish. India*, p. 596 (1878).

[2] Anderson, *Anatomical and Zoological Researches*, etc., I, *Pisces*, p. 868 (1878).

Nemachilus multifasciatus (Day) Vinciguerra.

1890. *Nemachilus multifasciatus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, pp. 209-211.

In his revision of *Nemachilus* from Burma, Hora[1] remarked " I have not yet determined exactly the specific characters of Day's *N. multifasciatus* and have, therefore, left out of consideration Vinciguerra's specimens referred to this species". As regards the identity of Day's *multifasciatus*, the situation has not altered so far, and in spite of the extensive collections that have been made in the Darjiling Himalayas during recent years, not a single specimen of the species has been obtained. Vinciguerra's *multifasciatus* has, however, been recorded by Mukerji[2] from northern Burma and Siam, and he gives a detailed description of the species from fresh specimens. In the present state of our knowledge it is not possible to be certain whether the Burmo-Siamese form is conspecific with the Eastern Himalayan form. Until further material is obtained from the latter locality, we propose to designate the authorship of the species as noted above.

In Mr. Sondhi's collection there is only one specimen of this species obtained in the western drainage of the Pegu Yomas at Gyobyu Chaung, west of the new dam line. It is 52 mm. in total length without the caudal and is a well preserved specimen. The colouration of the body is somewhat faded, but the black vertical bar at the base of the caudal and the characteristic colour pattern on the caudal fin are well marked.

Lepidocephalichthys berdmorei (Blyth).

1929. *Lepidocephalichthys berdmorei*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 191.

Lepidocephalichthys berdmorei is the most widely distributed loach in the Burmese waters. Six specimens of the species were obtained by Mr. Sondhi at Repiu. The fish is usually found in pools and puddles in the course of streams among debris at the bottom.

The species is known as " *Nga-tha-lay daw* " by the Guttum people.

Acanthopsis choirorhynchus (Bleeker).

1916. *Acanthopsis choirorhynchus*, Weber and Beaufort, *Fish. Indo-Austral. Archipel.* III, p. 25, figs. 8 and 9.

Acanthopsis choirorhynchus is represented by a single specimen in Mr. Sondhi's collection. It is a young specimen, 98·3 mm. in total length, and was obtained in the Pegu Yomas. Besides Burma the species is known from Malay Peninsula, Annam, Borneo, Java and Sumatra. So far it has not been recorded from India.

Ophicephalus gachua Ham. Buch.

1918. *Ophiocephalus harcourt-butleri*, Annandale, *Rec. Ind. Mus.*, XIV, p. 54, pl. ii, fig. 7; pl. iv, figs. 16, 17.
1921. *Ophiocephalus harcourt-butleri*, Hora, *Rec. Ind. Mus.*, XXII, p. 208.
1929. *Ophicephalus gachua*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 215.

Ophicephalus gachua is a widely distributed and variable species of the Oriental Region. Its much more marked amphibious mode of

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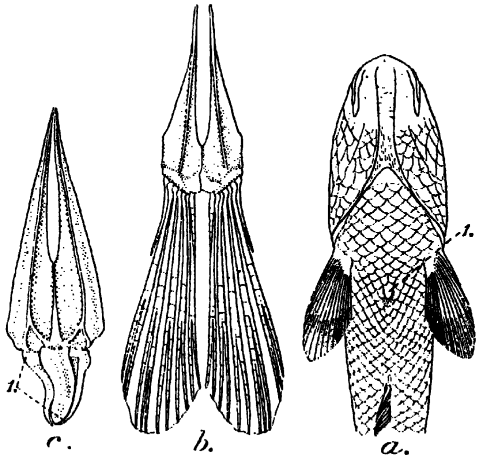
[1] Hora, *Rec. Ind. Mus.*, XXXI, p. 314 (1929).
[2] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, 1934 (in press).

life is probably responsible for a certain amount of variation exhibited by the species. Moreover, during growth the fish undergoes considerable changes in proportions, etc. In 1918, Annandale (*op. cit.*) described a new species, *O. harcourt-butleri* from the Inlé Basin, S. Shan States, and remarked that it is a "small species resembling *O. gachua*, but distinguished by the smaller scales on the head, the longer, narrower, less flattened head, etc." According to Annandale this species "is abundant all over Yawnghwe and the neighbouring states......Large numbers are sold in the local markets." One of us (Hora, *op. cit.*) recorded this species from the Manipur Valley where it was found to be abundant in marshy places. In 1893, Boulenger[1] had recorded *O. gachua* from Fort Stedman, and the belief has been growing with us that *O. harcourt-butleri* is probably conspecific with *O. gachua*. After an examination of a large number of specimens in the collection of the Zoological Survey of India from widely separated localities, we are now of opinion that the differences pointed out by Annandale lose all significance when large series of specimens are examined. Annandale's *O. harcourt-butleri* cannot, therefore, be regarded as distinct from *O. gachua*.



TEXT-FIG. 3.—*Ophicephalus gachua* Ham. Buch.
a. Ventral surface of head and anterior part of body of an abnormal specimen showing absence of ventral fins × $\frac{4}{5}$.
b. Skeleton of the rudiment of the pelvic fins and the basipterygia of the above × 4$\frac{1}{2}$.
c. Skeleton of the pelvic fins and the basipeterygia of a normal specimen × 4.
1.= Rudiment of the pelvic fins.

Five specimens of *O. gachua* were collected by Mr. Sondhi, 4 from the S. Shan States and 1 from the Pegu Yomas. The specimen collected at Pangtara, about 145 mm. in total length without the caudal, is of special interest as it is deficient in both the pelvic fins. According

[1] Boulenger, *Ann. Mag. Nat. Hist.* (6), XII, pp. 198-203 (1893).

to Day[1] "It is not uncommon in India to find specimens of *Ophiocephalus gachua* having a ventral fin deficient but I have never observed both wanting." With the exception of the specimen under report, we have not come across any example of *O. gachua* lacking one or both the ventral fins. In the abnormal specimen the region of the origin of the pelvic fins is marked by the presence of a large scale, which on dissection proved to be a bony structure representing the two lost fins. The pelvic girdle or the basipterygia are of the normal type, except that they lie closer together and have coalesced in the basal region to form a single structure. The basipterygia are further fused with the scale-like structure noted above. The latter was partly imbedded in the skin but was free distally. It is thus seen that the remnants of the pelvic fins and their supporting bones have become fused to form a single bony mass. For convenience of reference, we reproduce (Text.-fig. 3) a drawing of the pelvic fins and the basipterygia of the normal specimen of *O. gachua* for comparison with the abnormal structure illustrated here.

In April, 1932, we received three specimens of *Channa orientalis* and three of *Ophicephalus gachua* from the Colombo Museum. We were informed that the specimens of both the species had been taken together. One of these specimens of *C. orientalis* was dissected very carefully to see if there was any rudiment left of the pelvic fins or the basipterygia, but we were unable to find any trace of either. This shows that in *Channa* the pelvic fins are totally absent, whereas in the abnormal specimen of *O. gachua*. the absence of the pelvic fins has to be regarded as a mere deformity due to some injury or pathogenic condition. On previous occasions we[2] have referred to the absence of paired fins in fishes and discussed the significance of this phenomenon in the taxonomy of the forms concerned. As regards the systematic position of *Channa* and *Ophicephalus*, Myers and Shapovalov[3] have recently given some evidence to show that *Channa* probably comprises series of anomalous specimens hardly distinguishable from species of *Ophicephalus* except on the character of the pelvic fins. We also feel that there is a great deal to be said for this view, for an examination of the material of both the genera in the Indian Museum has shown that if the absence of the pelvic fins is ignored it is very difficult to distinguish species of *Channa* from certain species of *Ophicephalus*. As an example it may be noted that we have not been able to find any distinctive feature in the type-specimens of *Channa burmanica* Chaudhuri[4] by which the species can be distinguished from the common form, *O. gachua*. The abnormal specimen reported here raises several questions of interest, but we refrain from discussing the problem as Deraniyagala[5] proposes to make an intensive study of *C. orientalis* and *O. gachua* with a view to elucidate the systematic position of the two genera.

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[1] Day, *Fish. India*, p. 368 (1878).

[2] Hora, *Rec. Ind. Mus.*, XXII, pp. 27-32, figs. 1 and 2 (1921); *Nature*, London, CXXVI, pp. 435, 436, fig. 1 (1930).

Mukerji, *Annot. Zool. Japon.*, XIII, No. 5, pp. 441-444 (1932); *Journ. Bombay Nat. Hist. Soc.*, XXXVII, 1934 (in press).

[3] Myers and Shapovalov, *Peking Nat. Hist. Bull.*, VI, pt. ii. pp. 32-37 (1931-32).

[4] Chaudhuri, *Rec. Ind. Mus.*, XVI, pp. 284-286, pl. xxii, figs. 4, 4*a*, 4*b* (1919).

[5] Deraniyagala, *Spol. Zeylanica*, XVII, pt. i. pp. 40, 41 (1932).

Mastacembelus armatus (Lacépède).

1929. *Mastacembelus armatus*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, pp. 213, 214.

A young specimen of *Mastacembelus armatus*, 140 mm. in total length was obtained by Mr. Sondhi in the western drainage of the Pegu Yomas. The colouration of the specimen is somewhat different from the normal type. There are two short bands in the posterior portion of the head forming a cross on the nape. A black band along the dorsal surface at the sides of the spines runs in an undulating course and the second is a much narrower band that runs along the lateral line. A still lighter and narrower band runs along the middle of the lower half of the body and is continued forwards on the gill-cover. Behind the vent all these bands break up and form the reticulated pattern characteristic of the species. In the anterior region the fish is marked with 3 lateral stripes decreasing in width from above downwards.

Ambassis ranga (Ham. Buch.).

1929. *Ambassis ranga*, Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, pp. 210, 211.

There are two young specimens of *Ambassis ranga* in the collection. They were obtained by Mr. Sondhi in the Pegu Yomas.

MGIPC—M—III-8-16—4-4-34—510.

ON TREMATODES FROM WILD DUCKS IN RANGOON.

By B. S. Gogate.

(*From the Biological Department, University of Rangoon.*)

Two ducks were dissected. The first, *Anas poecilorhyncha* Forester 1781, contained only three specimens of *Echinostoma revolutum* (Froelich 1802) Looss 1899. The second, *Dendrocygna javanica* (Gmelin 1789), was more heavily parasitized containing both Trematodes and Nematodes. The Trematodes consisted of two genera of Echinostomes and one genus of Schistosomes. The former were obtained from the intestine and the latter from clotted blood in the body-cavity. As the bird reached the laboratory sometime after it was shot, a detailed examination of the blood could not be carried out.

I am indebted to Prof. F. J. Meggitt for his suggestions and criticism in the preparation of the manuscript.

Echinostoma revolutum (Froelich 1802) Looss 1899.

The only feature in which the parasites differ from the description of Lühe (1909, p. 69) is the size. The biggest of them is only a little longer than the smallest mentioned in the description.

Host.—*Anas poecilorhyncha* Forester 1781.
Location.—Intestine.
Locality.—Rangoon.

Paryphostomum testitrifolium, sp. nov.

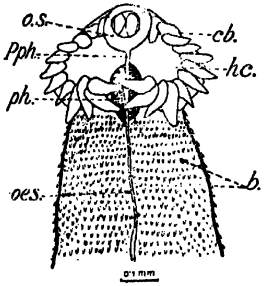
Description.—Body elongated, 3·5-5[1], armed with spines in front of ventral sucker, anterior end narrower than posterior. Maximum width (in region of testes) 0·555-0·952. Head collar strongly developed, with a single row of marginal spines, 27 in number, unbroken dorsally. Ventrally collar spines gathered into two "*end groups*" of 4 spines each.

Outermost spine of each end group 0·108-0·115×0·044-0·0479; other marginal spines 0·064-0·101×0·03-0·0324. Oral sucker subterminal, 0·115×0·128. Prepharynx small, 0·027 long. Pharynx globular, 0·135 ×0·093. Oesophagus approximately 0·464 long. Rami of intestine starting in front of the ventral sucker and running posteriorly nearly to posterior end of body. Ventral sucker very large, 0·547×0·539, enclosing a spacious cup-shaped cavity. Genital pore median anterior to ventral sucker, posterior to intestinal bifurcation.

Testes branched, trifoliate, each with two anterolateral and one postero-median branches, lying one behind the other in the median line in the hinder half of the body. Posterior testis larger than anterior.

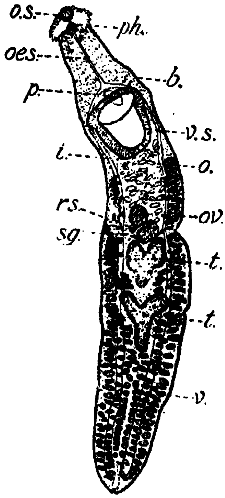
[1] All measurements are given in millimetres.

Cirrus-pouch moderately developed, 0·197×0·0945, dorsal to ventral sucker and oblique to its axis.



TEXT-FIG. 1.—*Paryphostomum testitrifolium*, sp. nov.—Head region.[1]

Ovary globular, 0·17×0·165, situated slightly to one side of the median line of body, pretesticular, separated from anterior testis by the length of the shell gland complex. Latter prominent, bigger than ovary, 0·19×0·275 in median line of body. Receptaculum-seminis small,



TEXT-FIG. 2.—*Paryphostomum testitrifolium*, sp. nov.—Entire worm.

[1] ABBREVIATIONS USED IN TEXT-FIGURES.

b., body spines; *cb.*, collar spines; *hc.*, head collar; *i.*, intestine; *o.*, ova; *oes.*, oesophagus; *os.*, oral sucker; *ov.*, ovary; *p.*, cirrus-pouch; *ph.*, pharynx; *Pph.*, prepharynx; *rs.*, receptaculum-seminis; *sg.*, shell gland; *t.*, testes; *v.s.*, ventral sucker; *v.*, vitelline glands.

approximately 0·055 diameter posterior to ovary. Vitellaria extending from behind the ventral sucker to the posterior end of body, extra and overcaecal and occasionally intercaecal in the ovarian and testicular regions, distinctly intercaecal in post-testicular region, filling the whole post-testicular part of body with loosely packed follicles. Transverse vitelline ducts running along anterior margin of anterior testis, opening into a small vitelline reservoir. Uterus short not much coiled, pre-testicular and intercaecal. Vagina passing dorsal to ventral sucker. Ova small, numerous, 0·0771 × 0·0409.

Host.—*Dendrocygna javanica* (Gmelin 1789).
Location.—Intestine.
Locality.—Rangoon.

The genus *Paryphostomum* Dietz 1909, type-species *P. radiatum* (Dujardin 1845) Dietz 1909 from *Phalacocorax carbo*, has been characterized by "the presence of a double row of collar spines." Edwards (1927) redescribed this type-species and amongst other minor differences, he found that the collar spines invariably occurred in a single dorsally unbroken row. In view of this observation, corroborated by those given above, either the original diagnosis is inaccurate in this respect or the constancy of the character is dubious ; in either case no generic importance can be attached to it and the diagnosis should be altered to "Collar spines in a single or double dorsally unbroken row".

The presence of a double row of collar spines together with differences in the shape and disposition of the testes and cirrus sac, separate the present form from *P. segregatum* Dietz 1909 and *P. indicum* Bhalerao 1931.

It agrees with *P. radiatum* (Dujardin 1845) in the possession of a single row of collar spines, and the number constituting the row, but differs in (1) the ratio of its suckers ; (2) the trifoliate nature of its testes ; (3) the size and shape of the cirrus sac ; and (4) the Anseriform host.

The differences being sufficient for the creation of a new species for which I propose the name *P. testitrifolium* in view of the trifoliate nature of its testes.

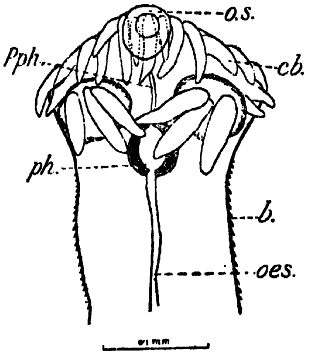
Key for the species of the genus *Paryphostomum* Dietz 1909—

1.	Collar spines in a single row . . .	2.
	Collar spines in a double row . . .	4.
2.	Testes 4-5 lobed rosette-shaped . . .	*P. radiatum* (Dujardin 1845).
3.	Testes 3 lobed, two anterolateral and one postero-median lobe	*P. testitrifolium*, sp. nov.
4.	Collar spines 27 in number, cirrus sac not extending behind ventral sucker . .	*P. segregatum* Dietz 1909.
5.	Collar spines 42 in number, cirrus sac extending behind ventral sucker . . .	*P. indicum* Bhalerao 1931.

Petasiger minutissimus, sp. nov.

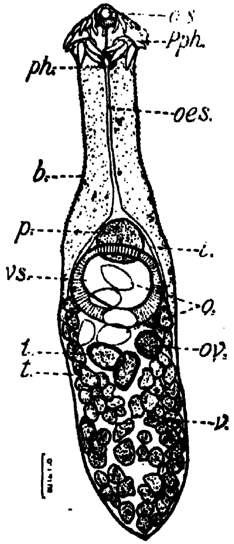
Description.—Body small, elongated, 0·984-1·338, anterior end narrower, with well-developed head collar bearing 23 collar spines, of which 17 spines are arranged in a single dorsally uninterrupted row, each spine 0·0368-0·0613 × 0·01-0·0171, the remaining 6 spines being in two ventral "*end groups*", each containing three spines, 0·0552-0·073 ×

0·015-0·0225, borne on a very much raised portion of the collar. Maximum width of the body in region immediately behind ventral sucker—0·291-0·349. Body anterior to ventral sucker covered with spines. Oral sucker almost circular, 0·045-0·053. Prepharynx 0·05-0·06 long.



TEXT-FIG 3.—*Petasiger minutissimus*, sp. nov.—Head region.

Pharynx globular, 0·0495-0·05. Oesophagus thin, 0·3-0·33 long. Intestinal caeca narrow, branching some distance in front of ventral sucker, from the posterior margin of the ventral sucker completely hidden under excessively developed vitelline follicles.



TEXT-FIG. 4.—*Petasiger minutissimus*, sp. nov.—Entire worm.

Ventral sucker prominent, central, broader than long, 0·1771-0·195 ×0·198-0·226. Genital pore anterior to ventral sucker, immediately ventral to intestinal bifurcation.

Testes oval, partly overlapping and with long axes almost at right angles to each other. Anterior testis a little behind posterior margin of ventral sucker, transverse to axis of body; posterior with long axis parallel to body. Cirrus-pouch broader than long, 0·113×0·121, dorsal to ventral sucker, approximately half covered by anterior margin of ventral sucker, the other half lying between it and the intestinal bifurcation.

Ovary ovoid, 0·0633-0·064×0·066, close to ventral sucker, lateral, partly in zone of anterior testis, in some specimens, in others partly covered by posterior margin of the ventral sucker. Receptaculum seminis and shell gland obscured by the vitelline follicles. Vitelline follicles, in thick lateral bands in ovarian and testicular regions extending from level of posterior margin of ventral sucker to posterior end of body, and filling loosely median field also in post-testicular region leaving only a narrow median space.

Uterus short, pretesticular. Ova few, large, 0·0592-0·093×0·0368-0·048.

Host.—Dendrocygna javanica (Gmelin 1789).
Location.—Intestine.
Locality.—Rangoon.

Of the species of the genus *Petasiger*, Dietz 1909, the Burmese form most closely resembles *P. neocomense* Führmann 1928, with which it has in common the following characters:—

1. Single dorsally uninterrupted row of collar spines, with two *end groups* borne on a much raised portion on the ventral aspect.
2. Shape and the disposition of testes.
3. The position of the ovary.

It differs, however, in the following points:—

1. The total number of collar spines, and the number of spines constituting the *end groups*.
2. The distribution of the vitelline follicles.
3. The overlapping of the testes.
4. The size and shape of the cirrus-pouch.
5. The shape and size of the body and the Anseriform host.

The present form, therefore, constitutes a new species, for which I propose the name *P. minutissimus*, separating it from the other species of the genus by the characters given in the following key:—

1. Collar spines in double row	2.
Collar spines in single row	4.
2. Spines 27 in number. Anterior end narrowed into a neck; cirrus-pouch round . .	*P. excretus* Dietz 1909.
3. Spines 19-21 in number. Anterior end not narrowed into a neck; cirrus-pouch elongated and oblique	*P. pungens* (V. Linstow) 1893.
4. Spines 27 in number. Cirrus-pouch elongated and parallel to the axis of the body. Posterior end more narrow. Vitelline follicles sparse and mostly lateral, not reaching posterior end	*P. neocomense* Führmann 1928.

5. Spines 19 in number. Anterior end narrowed into a neck and cirrus-pouch elongated and oblique. Posterior end more narrow. Vitelline glands not reaching posterior end, mostly lateral . . . . . *P. nitidus* Linton. 1928.
6. Spines 23 in number. Cirrus-pouch round. Posterior end rounded. Vitelline follicles filling median field in post-testicular region, reaching posterior end . . *P. minutissimus*, sp. nov.

Genus **Ornithobilharzia** Odhner 1912.

Ornithobilharzia sp.

Two immature male specimens were obtained from blood already clotting. Length 9·5, Breadth 0·488. Spines and tubercles present on the body. Oral sucker 0·196 in diameter. Ventral sucker pedunculated, 0·472×0·417. Intestinal caeca long, running independently for most of their lengths, joining to form a common caecum approximately 0·52 from the posterior end. Testes approximately 70, circular, feebly developed. Cirrus-pouch rudiment posterior to ventral sucker. Gynacophoric canal well developed.

Host.—*Dendrocygna javanica* (Gmelin 1789).
Location.—Vascular system (?).
Locality.—Rangoon.

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A NEW SPECIES OF *XERIS* (HYMENOPTERA-SIRICIDAE) FROM THE HIMALAYAS.

By J. CHESTER BRADLEY, *M.S.*, *Ph.D.*, *F.E.S.*, *Cornell University, Ithaca, New York.*

Table of Palaearctic species of *Xeris*.

Vertex above ocelli smooth and polished, with only a few punctures along median line and in a sparse band above each eye; shoulders with a white stripe. Europe .	*spectrum.*
Vertex above ocelli densely punctate; the smooth polished area reduced to a spot on each side at summit; shoulders with only a white spot	*himalayensis*, sp. nov.

Xeris himalayensis, sp. nov.

♀ Head and antennae entirely black, except for small occipital spots. Thorax and abdomen entirely black, except for a yellow spot on cephalic aspect, extending slightly on to dorsal aspect of each shoulder and a pale area at base of sheaths of ovipositor. Wings hyaline, slightly stained yellowish, apical margins weakly clouded, costal cell dark brown. Front coxae black, the others brownish, rest of legs testaceous, the trochanters, knee-joints and hind femora somewhat paler.

Head densely granulate-punctate, smooth areas at summit of vertex; clypeus more coarsely sculptured than in *spectrum*, ridge on temples as in *spectrum*, but a row of punctures in front of it, another behind eyes, these connected below by transversely elongated punctures, all of which are absent in *spectrum*, temples behind ridge much more densely punctate than in *spectrum*. In other respects the structure not noticeably dissimilar from *spectrum*.

♂ Head black except for large occipital spots; thorax black except for lateral pronotal stripe not reaching to base of wings; abdomen reddish black, wings hyaline, with a trace of clouding at margins, and costal cell brown.

Head sculptured as in the female, the area on the temples in front of the ridge with more punctures.

Holotype, Female: Deoban, Chakrata Div., United Provinces, India; altitude 9,000 ft.; 17-18 June 1923, Dr. C. F. C. Beeson (United States National Museum, Catalogue No. 49312).

Allotype, Male: Deoban, June 6, 1923, Dr. S. K. Pillai (United States National Museum, Catalogue No. 49312).

A NEW GENUS OF BLOOD FLUKES OF THE FAMILY SPIRORCHIDAE, FROM THE TORTOISE, *HARDELLA THURGI* (GRAY).

By Bipin Bihari Sinha, *M.Sc., Research Scholar, University of Lucknow.*

The family Spirorchidae was erected by Stunkard (1921) to include the blood flukes from the turtles and originally contained only two genera—*Spirorchis* and *Hapalotrema*—which differ from each other in many features of their anatomy, and were placed in distinct sub-families, Spirorchinae and Hapalotreminae. The same year Stunkard had shown that *Spirorchis* MacCallum, 1918, and *Proparorchis* Ward, 1921, are synonymous thereby invalidating the family Proparorchidae as defined by the latter author. The bulk of the work on the family has been done by Stunkard, who in 1922 described two new genera, *Henotosoma* and *Hapalorhynchus*, one under each of the two sub-families, from North American turtles. The same author (1923), while reviewing the family Spirorchidae, described a new genus, *Haematotrema*, and several new species of the genus *Spirorchis*. Subsequently, he has considerably added to our knowledge of the family and has further described two new genera, *Vasotrema* and *Unicaecum*, from tortoises. Ejsmont (1927) added the genus, *Spirhapalum*, from the blood vessels of *Emys orbicularis* and erected the genus, *Diarmostorchis* for *Spirorchis blandingi* of MacCallum (1926), owing to the position of the ovary between the testes. Thapar (1933) described a new genus *Tremarhynchus*, from an Indian tortoise, *Trionyx gangeticus* and considered it to be a connecting link between the two known genera of the sub-family Hapalotreminae Stunkard, 1921. Mehra (1933) described two species of a new genus, *Coeuritrema*, from Allahabad and further discussed the relationships of the families of the blood flukes. The present communication deals with an account of another new genus of blood flukes from India, collected from the larger blood vessels of a tortoise *Hardella thurgi* (Gray).

The work was undertaken at the suggestion of Dr. G. S. Thapar, to whom I am deeply indebted for constant guidance and the interest he has taken in my work. He made helpful suggestions in connection with the preparation of the paper for the press and also placed the use of his private library at my disposal.

Gomtiotrema sanguina, gen. *et* sp. nov.

The parasite is a hermaphroditic distome, elongated and flattened in form (Text-fig. 1). It is widest in the region of the testes, gradually tapering towards the anterior end. The body is thin and transparent, 4·13 mm. in length and ·41 mm. in greatest breadth. The body is covered over with a thin cuticle which is devoid of any hooks or spines. This cuticle is inturned at the oral sucker, the genital pore and the excretory pore.

The oral sucker is situated at the extreme anterior end of the body and is protrusible. It is oval in shape, about one-half protruding out at the anterior end. It is slightly larger than the ventral sucker, ·125 mm. long by ·075 mm. broad. The ventral sucker is circular and also protrusible. It is situated at about one-third the distance from the anterior end of the body, its diameter is ·105 mm. The oral sucker

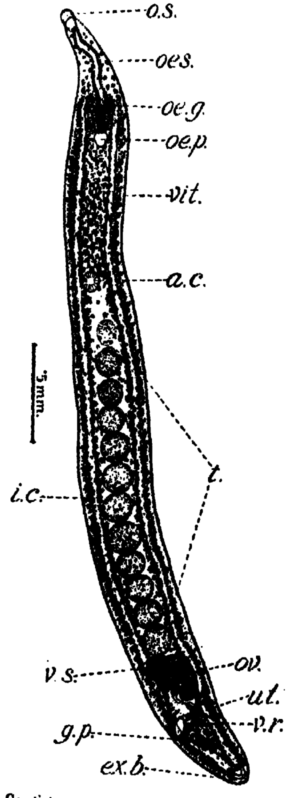

Fig. I.—*Gomtiotrema sanguina*, gen. *et* sp. nov. Dorsal view.
a. c.=acetabulum; *c. v. d.*=common vitelline duct; *e.*=egg; *ex. b.*=excretory bladder; *g. p.*=genital pore; *i. c.*=intestinal caeca; *l. c.*=Laurer's canal; *o. d.*=oviduct; *oes.*=oesophagus; *oe. g.*=oesophageal gland; *oe. p.*=oesophageal pouch; *oo.*,=oötype; *o.s.*=oral sucker; *ov.*=ovary; *r. s.*=receptaculum seminis; *s. g.*=shell glands; *t.*=testes; *ut.*=uterus; *vit.*=vitellaria; *v. r.*=vitelline reservoir; *v. s.*=vesicula seminalis.

leads into a long oesophagus which follows a sinuous course to the point of its bifurcation into the intestinal caeca. It is ·53 mm. long and is

surrounded by a layer of gland cells which form a compact glandular mass round the posterior one-fourth or so of the oesophagus. Posteriorly, the oesophagus is produced into a pocket-like structure that hangs freely in the parenchyma. The intestinal caeca arise in front of the median pocket from the oesophagus and run forwards anteriorly for a short distance and curve backwards, thereby forming an anterior loop at the point of their origin. The caeca run backwards almost parallel to the body wall and extend upto the posterior end of the body. Just before their termination posteriorly they bend inwards for a short distance and then run backwards; they are slender tubes of a more or less uniform diameter.

The excretory pore is situated at the posterior end of the body and is slightly dorsal in position. It leads into two elongated collecting ducts. These ducts pass forwards laterally to the ends of the intestinal caeca, where they narrow out to form the longitudinal ducts running dorsal to the caeca on either side of the body.

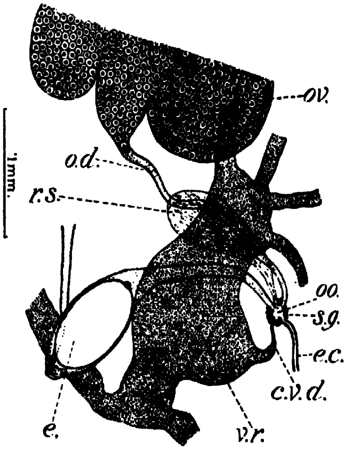

Fig. II.—Female genital organs of *Gomtiotrema sanguina*, gen. *et* sp. nov. Greatly enlarged. For explanation of lettering see fig. 1.

The female reproductive organs consist of a single dome-shaped ovary, trilobed posteriorly. It is situated ·51 mm. in front of the posterior end of the body and is ·25 mm. by ·22 mm. in size. The oviduct arises from the middle lobe of the ovary at the posterior end and passes on the right side of the body. The oviduct after a short course (Text-fig. 2), receives the common vitelline duct from the vitelline reservoir and thus forms the oötype. The receptaculum seminis and the Laurer's canal also meet it at this point and the latter opens to the outside on the dorsal surface behind the region of the vitelline reservoir. The point of union of all these ducts is further marked by the presence of minute shell gland cells, arranged radially about the oötype.

The vitellaria are voluminous and well developed. They consist of masses of follicles on either side of the intestinal caeca, from the oral sucker to the posterior end of the body, but in front of the acetabulum and behind the vitelline reservoir they fill up all the spaces even between the caeca. Behind the genital pore, the ducts from the vitellaria unite together by transverse ducts to form the vitelline reservoir, from where the common vitelline duct takes its origin and opens at the oötype.

The uterus is short and arises from the oötype. It opens on the lateral side of the body at the genital pore situated outside the left intestinal caecum. A single large egg was found in the uterus, its dimensions are ·088 mm. long by ·050 mm. broad. It bears a knob-like projection at one end and is provided with a thick shell of a golden brown colour.

The male reproductive system is characteristic of the sub-family Spirorchinae. There are twelve testes, arranged in a linear series in the intercaecal space. The anterior two testes are separated from each other and also from the rest, but the remaining ten testes are joined end to end. They occupy a region 1·74 mm. in length, the anterior testis being at a distance of 1·58 mm. from the anterior end of the body. They are roughly oval to spherical in shape and vary in size. Beginning from the anterior testis, they are ·12 mm. × ·11 mm., ·15 mm. × ·15 mm., ·14 mm. × ·14 mm., ·14 mm. × ·16 mm., ·16mm. × ·166 mm., ·15 mm. × ·166 mm., ·15 mm. × ·166 mm., ·16 mm. × ·19 mm., ·125 mm. × ·16 mm., ·127 mm. × ·155 mm., ·13 mm. × ·16 mm., and ·16 mm. × ·16 mm. respectively. The vesicula seminalis lies directly behind the posterior testis, touching the latter. It is widest anteriorly, and gradually tapers posteriorly to form a narrow ductus ejaculatorius. The latter opens at the genital pore besides the female opening, on the left side of the body at a distance of ·45 mm. from the posterior end.

The new genus, *Gomtiotrema*, resembles *Spirorchis*, *Henotosoma* and *Haematotrema* in the general topography of the organs, but is distinguished by the presence of a ventral sucker, shape and number of the testes and the presence of the intestinal loop at the anterior end. From *Diarmostorchis* it differs in the presence of the ventral sucker, the anterior intestinal loop and the relative position of the male and female genital organs. In the presence of the ventral sucker, it resembles the genera *Hapalotrema*, *Hapalorhynchus*, *Vasotrema*, *Spirhapalum*, *Tremarhynchus* and *Coeuritrema*, but differs from all these in the presence of twelve, entirely preovarial testes, the intestinal loop and the position of the genital pore. The only other genus of the family Spirorchidae is *Unicaecum* and from this, the new genus differs in the presence of both caeca, the presence of the ventral sucker, the position of the genital pore, the shape of the ovary and the anterior intestinal loop.

The diagnosis of the genus *Gomtiotrema* may be summarised thus :—

Hermaphroditic, blood-inhabiting distomes, with protrusible suckers; no cuticular spines; relatively large oesophagus; a loop in the intestinal caeca at their origin from the oesophagus. Testes twelve, oval to spherical, preovarial, arranged in linear series, intercaecal; vesicula seminalis continued into a narrow ejaculatory duct; genital pore lateral and posterior. Ovary dome-shaped, trilobed posteriorly, anterior to the

genital pore; vitellaria extensive; receptaculum seminis and Laurer's canal present. Uterus short, with a single large egg, which is knobbed.

Host.—*Hardella thurgi* (Gray).

Locality.—Lucknow, River Gomti.

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REPORT ON A COLLECTION OF CESTODES FROM LUCKNOW (U. P., INDIA).

By L. N. JOHRI, *Department of Biology, University of Rangoon.*

INTRODUCTION.

The material described in this paper was mainly collected during the years 1928-1930 from Lucknow, either from neighbouring villages or from the local markets and from the Lucknow Zoological Garden. Attention was concentrated upon avian fauna though from time to time other hosts were also dissected. The investigation was mainly devoted to pigeons, and altogether some 200 birds from neighbouring localities were dissected. The present work on Cestodes was originally started under the guidance of Dr. G. S. Thapar, but owing to the lack of literature in Lucknow, permission was granted by Prof. K. N. Bahl to carry out the identifications at the University of Rangoon under the supervision of Prof. F. J. Meggitt, to whom I have great pleasure in expressing my indebtedness for the help afforded me, for the use of his extensive library and the loan of specimens from his collection. My sincere thanks are also due to Dr. G. S. Thapar for his help at Lucknow.

INFECTION OF HOSTS.

A large number of the hosts dissected were pigeons. It was observed that infection was usually heavier in birds from slums and fed on a poor quantity of corn: wild forms from rural localities with but little chance of obtaining infected corn were either free from infection or not infected to the marked extent characteristic of those from the town. This indicates that the intermediate host is a weevil or some small arthropod present in corn. It is worth mention that in some cases the presence of large number of nematodes apparently prevents infection with cestodes. The degree of infection had marked effect upon the general health and vigour of the host, heavy infection resulting in extreme emaciation and weakness.[1] A careful examination of 20-30 pigeons kept in a cage showed that those heavily infected were listless and moped so much that no attempt was made to escape on the opening of the cage every morning and evening. One pigeon in particular would neither move nor mix freely with others; it was always found more or less at the same spot in the cage. A few gravid proglottides of *Raillietina* were found in the faeces. It died after a few days. Its intestine was so full of cestodes that the lumen was entirely obstructed. Even after their removal, deep furrow like streaks could be seen in the inner walls of the gut. Two tapeworms and a few incomplete strobilae were found free in the rectum.

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[1] In this connection reference may be made to somewhat similar observations made by Mr. G. Sondhi (*Proc. 14th Ind. Sci. Cong.*, pp. 193, 194, 1927).

No helminths were obtained from *Tylo alba javanica, Megalornis* sp. and only one small cestode, *R. polychalix* Kotlan, 1920, from *Psittacula krameri manillensis.*

Order CYCLOPHYLLIDEA Carus.

Family ANOPLOCEPHALIDAE Cholodkovsky 1902.

Subfamily ANOPLOCEPHALINAE Führmann 1907.

Anoplocephala Blanchard 1848.

Anoplocephala magna (Abildgaard 1789).

Host :—*Equus zebra* Linn. 1758.

Locality.—Zoological Garden, Lucknow.

The table on p. 155 gives the differences between the present form and those described by Baer (1927, pp. 26, 27).

Killigrewia Meggitt 1927.

Killigrewia frivola Meggitt 1927.

Host :—*Columba livia intermedia.*

Length 198, breadth 5·5. Scolex 0·104 long and 0·28 in maximum diameter. Genital cloaca absent. Maximum length of cirrus sac 0·315. Vesicula seminalis 0·128×0·082, present. Testes 113—154, usually 45-56, rarely, 82-89, poral; and usually 63-89, rarely 31, aporal. Otherwise agreeing with the discription of Meggitt (1927, p. 316).

Killigrewia Meggitt 1927 has been regarded (Führamann 1932, p. 58) as a synonym of *Aporina* Führmann 1902. The two genera differ in the disposition of the testes, these organs being in two distinct lateral groups separated by the female glands in *Killigrewia* and in a continuous band across the proglottis in *Aporina.* The validity of these organs as a generic character is recognised in the Dilepidinae, Führmann 1907, and according to the diagnoses given by Führmann (1932, pp. 85-116) *Parorchites* Führmann 1932 (or *Anomotaenia* Cohn 1899) and *Parvirostrum* Führmann 1907, *Dilepis* Weinland 1834 and *Proorchida* Führmann 1907, and *Kowalewskiella* Baczynska 1914 and *Paricterotaenia* Führmann 1932 are separated only by this character. There appears, therefore, no reason for considering *Killigrewia* as a synonym of *Aporina.*

Moniezia Blanchard 1891.

Moniezia expansa (Rudolphi 1810).

Host :—Goat and Sheep.

Moniezia trigonophora Stiles and Hassal 1893.

Host :—Sheep.

Genital cloaca present 0·14 long and 0·135 in maximum breadth, otherwise agreeing with the description of Baer (1927, pp. 72-73).

CHART 1.

	Length.	Breadth.	Diameter of scolex.	Diameter of sucker.	Genital cloaca.	Cirrus sac (size).	Cirrus.	Testes.	Receptaculum seminis.
A. magna (Abildgaard 1789) . . .	350[1]	25	3	1·2	Absen	1·4 × 0·01	Spiny	400—500	?
A. magna (present form)	157	11	6	2·6	Present	0·82-1·71 × 0·24	Without spines.	330—460	Very large

[1] All measurements in mm.

Subfamily THYSANOMINAE Führmann, 1907.

Stilesia Railliet 1893.

Stilesia globipunctata (Rivolta 1874) Railliet 1893.

Host :—Sheep.

Maximum length 93 and maximum breadth 1·05. Testes 3-6 on each side. Cirrus sac 0·072—0·074×0·027—0·041.

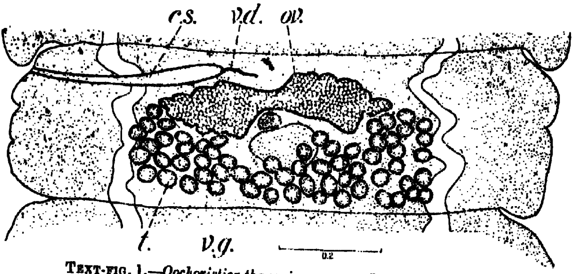
Subfamily LINSTOWIINAE Führmann 1907.

Oochoristica Lühe 1898.

Oochoristica thapari, sp. nov.

Host :—*Calotes* sp.

Maximum length 21 and the maximum breadth 2. All segments broader than long. Scolex 0·305 diameter. Genital pore in anterior third of the proglottis margin, often approaching extreme anterior. Genital ducts passing in between longitudinal excretory vessels. Testes 48-62 (max. diameter of testis 0·033—0·04), closely surrounding ovary and vitelline gland posteriorly and laterally and limited between the longitudinal excretory vessels, though a portion of a few of the testes lies dorsally to the excretory vessels. Cirrus sac 0·36—0·49 extending well past longitudinal excretory vessels.



TEXT-FIG. 1.—*Oochoristica thapari*, sp. nov. Mature proglottis.

The number of testes and the relative and absolute size of the cirrus sac separate the present form from all others of this genus except *O. surinamensis* Cohn 1902, which closely approaches the present form in the size of cirrus sac. The new species in addition to the larger number of the testes is further characterised by the dorsal position of the genital ducts in relation to the longitudinal excretory vessels.

Family DAVAINEIDAE Führmann 1907.

Subfamily DAVAINEINAE Braun 1900.

Cotugnia Diamare 1893.

Eighteen species of this genus have been recorded and are easily distinguishable except for *C. brotogerys* Meggitt 1915 and *C. digonopora*

(Pasquale 1890), *C. parva* Baer 1925 and *C. seni* Meggitt 1926. The first two only differ in the systematic position of the host and are otherwise similar; *C. brotogerys*, therefore, becomes a synonym of *C. digonopora*. *C. seni* differs from *C. parva* in the possession of a large receptaculum seminis, in the slightly smaller size of the rostellar hooks and the larger, absolute and relative, size of the cirrus sac, but with the present state of our knowledge of these forms it is not possible to be certain about their specific distinction.

Cotugnia bahli, sp. nov.

Host:—Turtur suratensis Linn. 1788.

Maximum length 55 and greatest breadth 3·3 (gravid segment) and 2·4 (mature segment). Scolex 0·5 diameter. Rostellum 0·34 diameter. Rostellar hooks approximately 332, 0·0125—0·0135 and 0·0175 long. Genital pore in anterior half of the proglottis margin. Cirrus sac 0·215-0·223 long, extending to the longitudinal excretory vessels. Testes 69-74, in two groups, arranged as in *C. govinda* (described below) except that they extend lateral to excretory vessels.

Of the species of *Cotugnia* with the testes in two groups, *C. collini* Führmann 1909 is separated by its larger rostellar hooks, greater number of testes and larger cirrus sac; *C. inaequalis* Führmann 1909 by the smaller number of testes and a smaller cirrus sac, *C. polycantha* Führmann 1909 by the smaller rostellar hooks and greater number of testes, *C. noctua* (described below) by the much larger number of testes, *C. fleari* Meggitt 1927 by the smaller number of testes and a longer cirrus sac, and *C. govinda* by the extension of the testes within the excretory vessels.

Cotugnia cuneata var. **nervosa** Meggitt 1924.

Host:—Columba intermedia.

This variety differs from var. *tenuis* in being much larger, the proglottis much broader, and in the development of strong musculature. Otherwise it agrees with the original description of the variety.

Cotugnia cuneata var. **tenuis** Meggitt 1924.

Host:—Columba intermedia.

Rostellar hooks 416, 0·011-0·013 and 0·0155-0·018 long. Testes 65-75 in a continuous band. Other details comparable with the original description.

Cotugnia digonopora (Pasquale 1890).

Host:—Columba intermedia.

Cirrus sac 0·32. Testes 128-158. Otherwise agreeing with Meggitt's description. Recorded from the Columbiformes for the first time.

Cotugnia fila Meggitt 1931.

Host:—Duck.

Cotugnia fleari Meggitt 1927.

Host :—*Columba intermedia.*

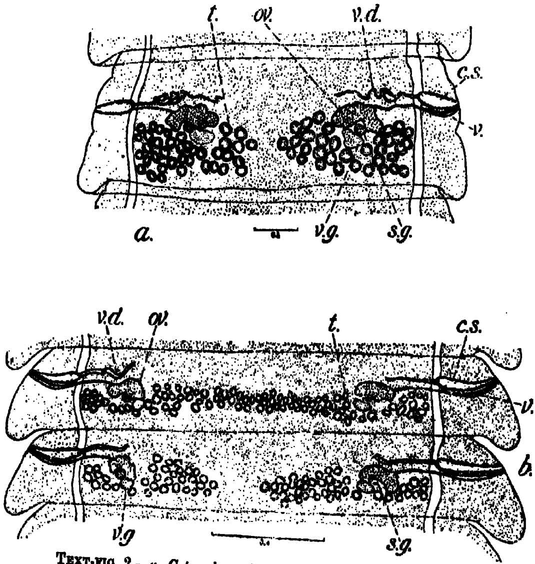
Length 53, breadth 1·5. Rostellar hooks approximately 308, 0·015 and 0·018 long. Cirrus sac 0·26 long extending to the longitudinal excretory vessel. Testes 46-57, in two clearly separated groups. These groups are not marked into poral and aporal groups. Receptaculum seminis present.

Cotugnia govinda, sp. nov.

Host :—*Milvus govinda.*

Locality :—Malhiabad, District Lucknow.

Maximum length 53·5 and greatest breadth 2. Scolex 0·565 diameter. Rostellum 0·25 diameter. Rostellar hooks 0·016 and 0·014 long, in two rows. Genital pore usually in anterior third of proglottis margin. In two proglottides female reproductive organs single, similar to those of *Raillietina* form. Cirrus sac 0·148-0·26 long, extending to or nearing to ventral longitudinal excretory vessel. Vas deferens partly straight and partly in convolutions. Testes in two clearly separated groups within



TEXT-FIG. 2.—*a. Cotugnia govinda*, sp. nov. Mature proglottis.
b. Cotugnia intermedia, sp. nov. Mature proglottis.

longitudinal excretory vessels: each group consists of 25-54, and again is subdivided into two, each postero-lateral to ovary; the two being joined by a chain of a few testes. Median medullary parenchyma free from testes. Gravid segments absent.

From *C. polycantha* Führmann 1909, *C. inaequalis* Führmann 1909. and *C. noctua* (described below) the present form is distinguished by the testes not extending lateral to excretory vessel. This is the first record of this genus from the Accipitriformes.

Cotugnia inaequalis Führmann 1909.

Host :—*Columba livia domestica.*

Cirrus sac 0·1-0·112, not reaching the ventral longitudinal excretory vessel. Testes approximately 57. Otherwise agreeing with the original details. First record from the Columbiformes.

Cotugnia intermedia, sp. nov.

Host :—*Columba intermedia.*

Maximum length 48. Greatest breadth 3·2. Scolex 0·44-0·525 diameter. Rostellum armed with double circle of hooks, 0·012-0·017 long, arranged alternately. Genital pore in anterior half of proglottis margin. Cirrus sac 0·18-0·268 long, just reaching or just passing ventral longitudinal excretory vessel. Vas deferens partly straight and partly in coils. Testes 63-90, in some segments appearing in two distinct groups, while in others as a single broad band stretching from side to side of the proglottis; in either case mostly within longitudinal excretory vessel, rarely one or two outside. The anterior border of proglottis free from testes.

The size of the rostellar hooks and cirrus sac, together with the number of the testes, clearly separates the present species from others of the same genus except *C. fastigata* Meggitt 1920 which is distinguished by the larger number of testes and a larger cirrus sac, *C. inaequalis* Führmann 1909 by its smaller cirrus sac; *C. polycantha* Führmann 1909 by the smaller rostellar hooks, smaller cirrus sac and the larger number of the testes, and *C. fila* Meggitt 1931 by fewer testes. In addition, from all forms it is distinguished by the possession of testes in two groups or in a single continuous band in the same strobilous. This is the sole major character separating it from *C. cuneata* Meggitt 1924; and if it be of no specific value, the two species will have to be regarded as identical.

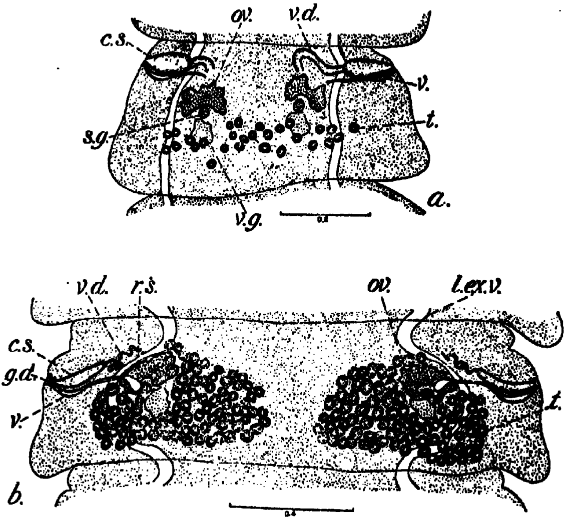
Cotugnia januaria, sp. nov.

Host :—*Gallus domesticus.*

Length 3-11. Breadth 0·28-0·8. Scolex 0·55-0·85 diameter. Rostellum 0·28 in diameter, armed with a double circle of approximately 403 hooks, 0·006-0·007 and 0·005-0·006 long respectively. Genital pore at anterior extreme margin of proglottis. Cirrus sac 0·11-0·14 long extending to and often crossing longitudinal excretory vessel; vas deferens, a short uncoiled wide tube. Testes 18-35, a single broad band across proglottis posterior to ovary and extending a little beyond the longitudinal excretory vessel: anterior and most of posterior area of proglottis entirely free from testes. The gravid segments absent. Last few segments much smaller than preceding ones.

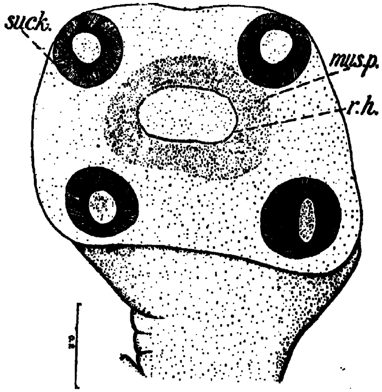
The present form is easily distinguished from the species of the same genus with the testes arranged in two distinct groups. *C. margereta*

Beddard 1916, is characterised by the rostellum being smaller than the sucker. *C. crassa* Führmann 1909, *C. digonopora* (Pasquale 1890), *C.*



Text-fig. 3.—*a. Cotugnia januaria*, sp. nov. Mature proglottis.
b. Cotugnia noctua, sp. nov. Mature proglottis.

fastigata Meggitt 1920 and *C. fuhrmanni* Baczynska 1914 are separated by the much greater number of testes, *C. joyeuxi* Baer 1924 by the larger rostellar hooks, and a smaller cirrus sac, *C. cuneata* Meggitt 1924, *C. parva*



Text-fig. 4—*Cotugnia januaria*, sp. nov. Scolex.

Baer 1925, *C. seni* Meggitt 1926 and *C. fila* Meggitt 1931, by the larger rostellar hooks, large number of testes and larger cirrus sac.

Cotugnia noctua, sp. nov.

Host :—*Columba intermedia.*

Length 51, maximum breadth 2. Scolex 0·51 diameter. Rostellum 0·225 diameter with double row of hooks, 0·012 and 0·018 long. Musculature with two layers of longitudinal muscles, the inner one the weaker and consisting of smaller and scattered muscular fibres. Transverse muscles not seen.

Genital pore in anterior half of proglottis margin. Genital cloaca poorly developed. Cirrus sac 0·176-0·2 long extending to ventral longitudinal excretory vessel. Coils of vas deferens few and small. Testes approximately 170-182, in two distinct groups, congregated round ovary on all sides and extending beyond ventral longitudinal excretory vessel. Gravid segments absent.

The possession of two distinct groups of testes in the present form distinguishes it from all the species of this genus with a single band of testes. *C. collini* Führmann 1909 is distinguished by the size of its rostellar hooks and cirrus sac. The smaller number of testes together with minor differences separates the remaining forms.

Cotugnia parva Baer 1925.

Hosts :—*Corvus macrorhynchus* and *Columba intermedia.*

Rostellar hooks 378-396, 0·015-0·016 and 0·018-0·02 long. Cirrus sac 0·101-0·106 long and 0·04 maximum diameter. Testes approximately 32-41.

Cotugnia polycantha Führmann 1909.

Host :—Pigeon.

Genital pore in anterior one-third of proglottis margin. Cirrus sac 0·168 to the ventral longitudinal excretory vessels. Testes, in two distinct groups, approximately 88.

Raillietina Führmann 1920.

Raillietina (Fuhrmanetta) echinobothridia (Mégnin 1880).

Host :—Jungle-fowl.

Rostellar hooks approximately 239, 0·011 and 0·017 long. Testes 30-32. Egg-capsules approximately 80.

Raillietina (Paroniella) reynoldsae (Meggitt 1926).

Host :—*Corvus splendens.*

Numerous small forms 0·9-2·0 long and 0·19-0·515 broad. Scolex 0·22 diameter rostellar hooks 144-167.

Raillietina (Paroniella) rangoonica (Subramanian 1928).

Host :—Milvus govinda.

Maximum length 98, maximum breadth 1·52. Scolex 0·27 diameter. Rostellar hooks 291. Acetabullar hooks absent. Cirrus sac 0·11-0·16. Vas deferens greatly convoluted. Testes 23-37, of which 5-8 poral and the rest aporal; no testis either anterior or posterior to ovary. Ovary with small processes marked anteriorly, extends from centre of the proglottis to its anterior border, sometimes touching it. Egg-capsules lateral to longitudinal excretory vessels but leaving clear margins at the sides.

Raillietina (Raillietina) flabralis Meggitt 1927.

Host :—Dichoceros bicornis bicornis.

Raillietina (Raillietina) fuhrmanni (Southwell 1922).

Host :—Crocopus chlorogaster.

Length 18-50, breadth 0·46-1·05. Scolex 0·23 maximum diameter. Rostellum 0·14 diameter, hooks in two rows, each 0·023-0·029 and 0·024-0·033. Cirrus sac 0·114-0·172 long. Testes 8-15. Egg capsules approximately 30-60 per segment, each containing 4-9 eggs extending external to excretory vessel.

Raillietina (Raillietina) galeritae Skrjabin 1914.

Host :—A small black bird (unidentified).

Maximum length 67, greatest breadth 0·55. Scolex 0·236 diameter. Rostellar hooks 254, 0·014 and 0·0175 long. Suckers nearly spherical, 0·116 maximum diameter. Acetabular hooks 7-8 rows. Cirrus sac 0·11-0·142×0·045. Egg capsules more irregularly packed than described by Skrjabin and not extending external to excretory vessel.

Raillietina (Raillietina) macrocirrosa Führmann 1909.

Host :—Francolinus sp.

Maximum length 89-125, breadth 0·655-0·7. Scolex 0·32 diameter. Rostellum 0·165 diameter. Rostellar hooks 320, 0·014 and 0·017 long. Genital pore in anterior half of proglottis margin. Cirrus sac 0·06-0·087 long. Cirrus simple and unarmed. (Führmann's form possesses a muscular cirrus, also thick and very much coiled). Testes 28-30, lateral and posterior to ovary. Egg capsules imperfectly developed. First record from the Galliformes.

Raillietina (Raillietina) michaelseni Baer 1925.

Host :—Pigeon.

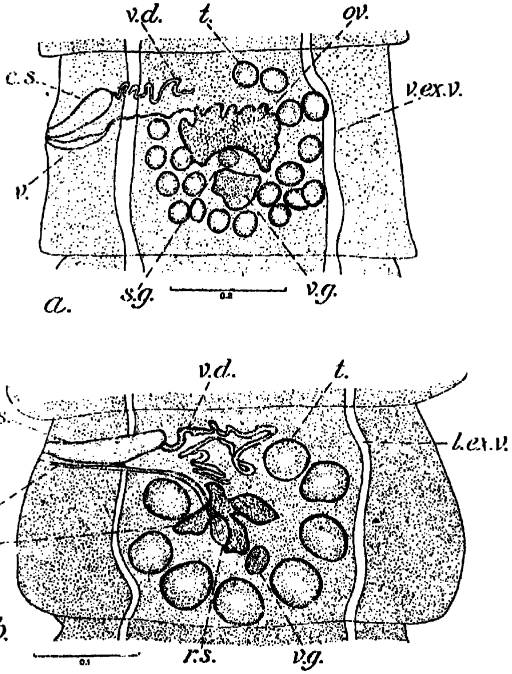
Maximum length 223, breadth 0·27. Scolex 0·26 diameter. Rostellar hooks 240-320, 0·014 and 0·0165 long. Testes 20-22, often 2-3 slightly

anterior to ovary on aporal side. Gravid segments absent. First record from the Columbiformes

Raillietina (Raillietina) penetrans nova, subsp. nov.

Host :—Indian Mynah.

Maximum length 248, maximum breadth 0·67. Scolex 0·25 diameter. Rostellar hooks 154-184, 0·014 and 0·019 long. Acetabullar hooks 4-5 rows. Musculature with two longitudinal muscular layers. Genital pore in anterior half of the proglottis margin. Genital cloaca very



TEXT-FIG. 5.—*a. Raillietina (Raillietina) penetrans nova,* subsp. nov. Mature proglottis. *b. Raillietina (Skrjabina) kakia,* sp. inq. Mature proglottis.

shallow. Cirrus sac 0·125-0·134 long, not or nearly touching ventral longitudinal excretory vessel. Cirrus unarmed. Testes 16-19 lateral and posterior to ovary, with a few anterior aporally. Egg-capsules 35-58 extending beyond the ventral longitudinal excretory vessel, each containing 5-7 eggs.

The following chart gives the differences between the present form and *R. (Raillietina) penetrans* Baczynska 1914 :—

CHART 2.

	Host.	Length.	Breadth.	Acetabular hooks.	Proglottides.	Muscles.	Genital cloaca.	Cirrus sac.	Testes (arrangement).	Diameter of onchosphere.
R. (*Raillietina*) *penetrans* Baczynska, 1914.	Galliformes	30-40	1·5	14-15 rows	All broader than longer.	4 longitudinal layers.	Muscular canal.	With specially developed muscles.	Two lateral groups.	0·0104
R. (*Raillietina*) *penetrans nova*, subsp. nov.	Passeriformes	248	0·67 (mature segment). 0·62 (gravid segment).	4-5 rows	Gravid ones longer than broad.	2 longitudinal layers.	No muscular canal.	Without specially developed muscles.	Nearly surrounding the ovary.	0·047—0·055

The differences as tabulated in the above chart distinguish the present form from *R.* (*Raillietina*) *penetrans* Baczynska 1914 but are not sufficient to justify the creation of a new species: it is, therefore, listed as a subspecies.

Raillietina (Raillietina) polychalix Kotlan 1920.

Hosts:—*Columba livia domestica*, and *Psittacula krameri manillensis*.

Maximum length 273, maximum breadth 0·75. Scolex 0·26 diameter. Rostellar hooks 324, 0·011 and 0·014 long. Suckers armed with 6-7 rows of hooks; the outermost with 0·006-0·007 long hooks, the size of hooks gradually diminishing towards the interior. Genital pore unilateral, in posterior half of the proglottis margin. Cirrus sac 0·125-0·13 long not reaching longitudinal excretory vessel. Vas deferens with numerous coils and surrounded by a large number of prostate cells. Testes 8-9. 30-40 egg-capsules extending laterally to longitudinal excretory vessels, each containing 6 eggs. The above description is of the forms from the Columbiformes: those from the Pisttaciformes differ in the following respects:—

Scolex 0·103 diameter. Rostellar hooks approximately 190, 0·0135 and 0·019 long. Testes 9-11. Cirrus sac 0·061 long. Egg-capsules 48.

These differences are not sufficient to justify the separation of the two forms

Raillietina (Raillietina) tunetensis Joyeux and Houdemer 1927.

Host:—*Columba livia domesticata*.

Cirrus sac 0·085 long and not extending to ventral longitudinal excretory vessel. Egg-capsules extending lateral to longitudinal excretory vessel.

Raillietina (Raillietina) volzi Führmann 1905.

Host:—*Columba livia domestica*.

Maximum length 313, maximum breadth 0·95. Scolex 0·235 maximum diameter. Rostellar hooks 182, 0·0135 and 0·016-0·0175 long. Suckers with 5-7 rows of hooks. Cirrus sac 0·133-0·17. Testes 30-32. 70-87 egg-capsules per segment, each egg-capsule contains 6-7 (usually 7) eggs. Otherwise agreeing with the original description. First record from the Columbiformes.

Raillietina (Skrjabina) kakia, sp. inq.

Host:—*Corvus splendens*.

A single specimen without scolex. Length 5, maximum breadth 0·45. Genital pore in anterior quarter of the proglottis margin. Genital cloaca absent. Cirrus sac 0·085-0·123, extending beyond ventral longitudinal excretory vessel. Receptaculum seminis slightly developed. Testes 6-10, surrounding ovary laterally, posteriorly with a few anteriorly. Ovary trilobed: sometimes these lobes give out small processes and occupy nearly centre of proglottis. Egg-capsules numerous in each segment, not extending beyond longitudinal excretory vessels.

The smaller number of testes of the present species separates it from all other forms of this sub-genus except *S. magnicoronata* (Führmann 1908), *S. maroteli* (Neveu-Lemaire 1912), *S. oligacantha* (Führmann 1908) and *S. retusa* (Clerc 1903). From these the first is separated by the relative and the absolute lengths of the cirrus, together with the position of testes at the posterior end of the segment. *S. oligacantha* and *S. retusa* are not sufficiently described to distinguish them from the present form, while details of *S. maroteli* are not available in Rangoon. The present form is, therefore, listed as a sp. inq.

Raillietina sp.

Host :—Gyps indicus.

Length 47, greatest breadth 0·2. Rostellar hooks approximately 300-357, 0·012 and 0·015-0·016 long. Acetabular hooks in 4-5 rows. Genital pore unilateral. Genital organs poorly developed and in an immature condition.

Family DILEPIDIDAE Führmann 1907.

Subfamily DIPYLIDIINAE Stiles 1896.

Dipylidium Leuckart 1863.

Dipylidium caninum (Linnaeus 1758).

Host :—Cats and dogs.

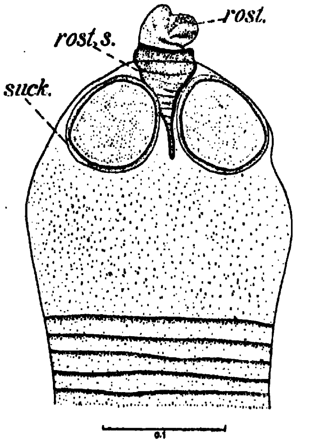
Eugonodaeum Beddard 1913.

Eugonodaeum ganjeum sp. nov.

Host :—Acridotheres tristis.

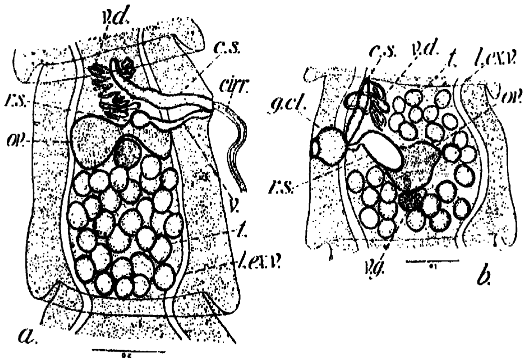
Length 31-35, maximum breadth 0·6 (mature segment) and 0·75 (gravid segment). Scolex globular slightly elongated, 0·178-0·185 in length and 0·225 maximum diameter. Rostellum ordinarily very small but seen protruding in the living specimen (it never extends so far as the length of the scolex). Rostellar hooks absent. A small rostellar pouch present, 0·78 long, not extending below the lower margin of the suckers. Suckers comparatively small, 0·083 maximum diameter, unarmed, situated at the anterior border of scolex. Genital pore irregularly alternates, in anterior fourth of the proglottis margin. Genital cloaca absent. Genital ducts pass between excretory vessels. Cirrus sac 0·315-0·366 × 0·027-0·042, crossing ventral longitudinal excretory vessel, obliquely directed towards anterior border of proglottis. Cirrus greatly elongated and protruded out of the proglottis (cirrus shown in diagram not complete, a part of it being damaged). Vas deferens greately coiled. Testes 27-40, posterior to ovary, and do not extend beyond ventral longitudinal excretory vessel, though a portion of some actually lies dorsally to the excretory vessel. Ovary in immature segments compact, in mature ones distinctly bilobed and extends from one longitudinal excretory vessel to the other. Uterus persistent, whole mounts and

transverse sections through gravid proglottis show that the egg-capsules are formed inside the uterus, which later expands to allow the egg-capsules



Text-fig. 6.—*Eugonodaeum ganjeum*, sp. nov. Scolex.

to become thickly crowded and extend beyond the ventral longitudinal excretory vessels.



Text-fig. 7.—*a. Eugonodaeum ganjeum*, sp. nov. Mature proglottis.
b. Eugonodaeum testifrontosa, sp. nov. Mature proglottis.

The present form may be included in either of the genera *Eugonodaeum* Beddard 1913 or *Unciunia* Skrjabin 1914. Originally these were separated by the possession of the unilateral genital pores in the former and of alternating genital pores and chitinous cirral hairs and spines of the latter. So far, including the new forms in the present paper, six species have been recorded.

CHART 3.

No.	Species.	Host.	Distribution.	Scolex. Rostellum.	Scolex. Rost. hooks.	Cirral hairs.	Genital pores.	Genital cloaca.	Genital ducts.	Cirrus sac (size).	Testes.
1	*Eugonodaeum oedicnemi* Beddard 1913.	Charadriiformes	New World	Present	Absent	Absent	Unilateral	Present	Between	Large	few
2	*Unciunia trichocirrosa* Skrjabin 1914.	Accipitriformes	Paraguay	Present	Absent	Present	Alternate	Present	?	0·11	30—35
3	*U. sudanea* Woodland 1928.	Galliformes	Sudan	Absent	Absent	Absent	Alternate	Present	Between	0·34—0·41	30—35
4	*U. acapillicirrosa* Moghe 1933.	Anseriformes	Nagpur, India.	Present	Absent	Absent	Alternate	Present	Between	0·19×0·057	60
5	*Eugonodaeum ganjeum*, sp. nov.	Passeriformes	Lucknow, India.	Present	Absent	Absent	Alternate	Absent	Between	0·315—0·366	27—40
6	*E. lastifrontosa*, sp. nov.	Charadriiformes	Lucknow, India.	?	?	Absent	Alternate	Present	Between	0·085—0·14	25—30

From the above table it will be seen that the cirral hairs have only once been found, *i.e.*, by the original investigator, and are absent in the other five forms. Apart from this, the only character separating the genera is the position of the genital pores, a character by itself not usually regarded as of generic rank (*e.g.*, *Raillietina*). Until the presence of cirral hairs is substantiated or until the hitherto undescribed female organs show any difference it is advisable to regard the genus *Unciunia* as a synonym of *Eugonodaeum*.

In the above table the differences between the present form and the previously described species are also tabulated.

Eugonodaeum testifrontosa, sp. nov.

Host :—Gallinago coelestis.

Greatest length 8, greatest breadth 0·4. Scolex absent. Genital pore irregularly alternating, slightly anterior to centre of the proglottis margin. Genital cloaca 0·07 deep $\times$0·064 maximum breadth, crossing ventral longitudinal excretory vessel. Cirrus sac 0·085-0·14$\times$0·023, running more or less parallel with longitudinal excretory vessels, and nearly touching anterior border of the proglottis. Vas deferens greatly coiled. Testes 25-30, almost filling the proglottis excepting the anterior poral area mainly occupied by cirrus sac, vas deferens, and receptaculum seminis. Ovary in centre of proglottis, compact. Vagina comparatively short opening into genital cloaca just posterior to cirrus sac. Receptaculum seminis large. Uterus persistent, greatly comparable to the previous form excepting that the capsules are limited between the ventral longitudinal excretory vessels. Maximum diameter of egg 0·027.

Unilateral genital pores together with the large size of the cirrus sac and the few testes are enough to distinguish the new species from *Eugonodaeum oedicnemi* Beddard 1913. The previous species *E. ganjeum* and *U. sudanea* Woodland 1928 differ in the larger size of the cirrus sac and the disposition of the genital organs : cirrus sac in the present case is nearly parallel with the longitudinal excretory vessels, and the testes are anterior to the ovary. The typical disposition of the cirrus sac. together with its small size and the absence of the hair cluster with the chitinous spine at its base, clearly distinguish the present form from *U. trichocirrosa* Skrjabin 1914. It is also separated from *U. acapillicirrosa* Moghe 1933 by the disposition of the testes and the cirrus sac together with the smaller number of the former.

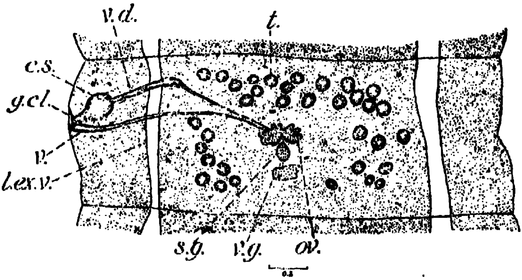
Subfamily Dilepidinae Führmann 1907.

Gidhaia indica, gen. *et* sp. nov.

Host :—Gyps indicus.

Maximum length 206, maximum breadth 5. Scolex absent. Segmentation distinct. Genital cloaca present. Genital pore irregularly alternates, in anterior half of proglottis margin. Cirrus sac very small, flask-shaped 0·206$\times$0·125 not extending to ventral longitudinal excretory vessel but well separated from it. Often a small external vesicula seminalis present. Genital ducts pass dorsal to longitudinal excretory vessels. Testes 32-40, anterior to female genital organs stretching

from one longitudinal excretory vessel to the other, poral and aporal groups, and also sometimes a few posterior to female genital organs. Receptaculum seminis absent. Ovary nearly in the centre of the proglottis or slightly poral. Small sac-like structures often appear on either side of shell gland and show the early development of uterus later on it is transversely elongated with lateral extremities sub-divided.



TEXT-FIG. 8.—*Gidhaia indica*, gen. et sp. nov. Mature proglottis.

The present form differs from *Parvirostrum magnisomum* Southwell 1930 by its smaller number of testes, larger size of cirrus sac and the absence of the receptaculum seminis.

The characters given above clearly indicate that the present form must be included in the *Dilepidinae*. From the genera of this subfamily with alternating genital pores such as *Angularella* Strand 1925 synonym *Angularia* Clerc 1906, *Parvirostrum* Führmann 1907, *Parictcrotaenia* Führmann 1932, and *Laterorchites* Führmann 1932, it is distinguished by the location of the testes anterior to ovary, from *Bancroftiella* Johnston 1911 and *Kowalewskiella* Baczynska 1914 by the course of the genital ducts and the presence of the testes lateral to the female genital organs, from *Cyclustera* Führmann 1901 by the irregularly alternating position of the genital pores and the absence of the ring-like uterus, from *Parorchites* Führmann 1932 (genital ducts passing dorsal to longitudinal excretory vessel) by the presence of the testes anterior to ovary and from *Liga* Weinland 1857, by the lateral disposition of testes and the absence of the tubular prolongations from eggs. It is, therefore, essential to create for it a new genus for which I propose the name *Gidhaia* with the present species as the type and with the following diagnosis :—

Dilepidinae; Genital pores irregularly alternate. Genital canals pass dorsally to longitudinal excretory vessels. Testes in two groups, poral and aporal, anteriorly to the female organs connected by several rows and with a few testes posterior to them. Female genital organs slightly poral or in centre of proglottis. Uterus transversely elongated, with lateral extremities greatly sub-divided. Adults in birds.

Type-species.—*Gidhaia indica*, sp. nov.

As in *Parvirostrum* Führmann 1908, the testes are never anterior to the ovary (Führmann 1932, p. 112). *Parvirostrum magnisomum* Southwell 1930 can not be included in that genus: its characters on the contratory place it in *Gidhaia*.

It should, however, be mentioned that genus *Taufikia* Woodland 1928 retains its validity and cannot in any way be considered as a synonym of *Parvirostrum* as has been suggested by Southwell (1930, p. 167).

Family HYMENOLEPIDIDAE Führmann 1907.

Subfamily HYMENOLEPIDINAE Perrier 1897.

Diploposthe Jacobi 1896.

Diploposthe laevis (Bloch 1782) Jacobi 1896.

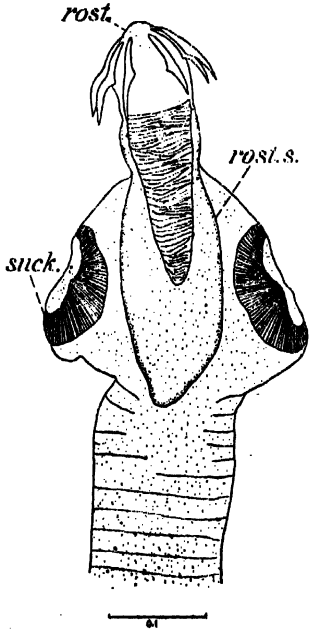
Host :—Duck.

Maximum length 166, maximum breadth 5·5. Genital pore slightly posterior to middle of the proglottis margin. Cirrus sac 0·658 ×0·11 extending to longitudinal excretory vessels. Testes three.

Hymenolepis Weinland 1858.

Hymenolepis clausa Linstow 1906.

Host :—*Columba intermedia*.



TEXT-FIG. 9.—*Hymenolepis clausa* Linstow. Scolex.

Rostellor hooks 0·068-0·084 long. Cirrus sac comparatively longer (0·272), extending half the breadth of the proglottis. Otherwise agreeing with the original description.

Hymenolepis furcata (Stieda 1862).

Host :—*Crocidura* sp.

Maximum length 3, maximum breadth 0·19. Scolex more or less rectangular, maximum breadth 0·24, and minimum breadth 0·17. Rostellar hooks 36, 0·016-0·018 long. Genital pore in anterior half of the proglottis margin. Cirrus sac 0·029-0·04, extending to ventral longitudinal excretory vessel. Of the two aporal testes, one internal and anterior to the other. Ovary small, poral mostly between cirrus sac and anterior testis.

The present form is placed in this species provisionally pending an investigation of the cestodes of *Crocidura*.

Hymenolepis multihamata Meggitt 1927.

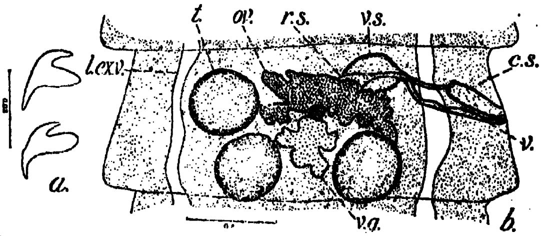
Host :—*Milvus govinda*.

Length 1·68, maximum breadth 0·27. Scolex 0·19 diameter. Rostellum 0·09 in diameter. Rostellar hooks 10, 0·114 and 0·075-0·087. Genital pore in anterior third of the proglottis margin. Cirrus sac 0·13-0·133 in mature segments, crossing longitudinal excretory vessels. Cirral spines absent.

Hymenolepis planestici Mayhew 1925.

Host :—*Acridotheres tristis*.

Length 175, greatest breadth 1·525. Scolex 0·31 diameter. Rostellum 0·08 diameter. Rostellar hooks 6, 0·017-0·02 long. Cirrus sac 0·125-0·135 long, extending to ventral longitudinal excretory vessel. Vas deferens short, narrow, ending in an external vesicula seminalis.



TEXT-FIG. 10.—*Hymenolepis planestici* Mayhew. *a*. Rostellar hooks. *b*. Mature proglottis.

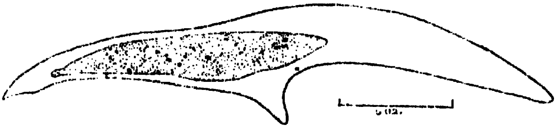
Receptaculum seminis often present but poorly developed. Genital atrium absent. Testes 0·16 in maximum diameter. Vitelline gland with 4-5 distinct lobes.

The Lucknow form differs from the original description (Mayhew 1925, p. 73) in the smaller number of rostellar hooks, slightly smaller relative size of cirrus sac and the lobed vitelline gland. These differences, however, do not appear sufficient to justify the creation of a new species.

Hymenolepis rugosa birmanica Meggitt 1924.

Host :—*Columba intermedia.*

Rostellar hooks 0·087-0·097 long. Cirrus sac 0·166 long, slightly exceeding half the breadth of the segment. Testes, variable in arrange-



TEXT-FIG. 11.—*Hymenolepis rugosa birmanica* Meggitt. Rostellar hook.

ment, usually in a transverse row towards the posterior margin of the proglottis.

H. serrata Führmann, 1906 greatly resembles *H. rugosa* Clerc, 1906. It differs only in the shape of hooks and the slightly smaller relative size of the cirrus sac, and specific identity of the two species appears to be clearly indicated.

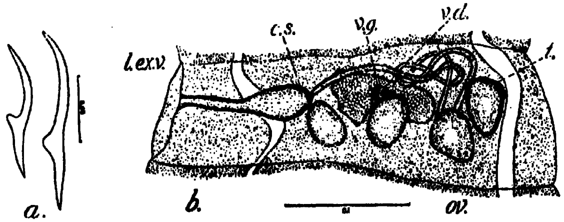
Oligorchis Führmann 1906.

Oligorchis hierticos, sp. nov.

Host :—*Milvus govinda.*

Locality.—Kakori, District Lucknow.

Maximum length 6·5, maximum breadth 0·45. Scolex 0·375-0·39 diameter. Rostellum 0·13 diameter, armed with approximately 16-18 hooks, 0·083-0·1 and 0·113-0·19 long. Suckers spherical, 0·11-0·14 diameter. Segments much broader than long. Genital pore unilateral, in anterior third of the proglottis margin. Genital ducts pass dorsal to the longitudinal excretory vessels. Musculature with two layers of longitudinal muscles, the bundles in the inner layer being feebly developed and lined internally by transverse muscles. Cirrus sac 0·065-0·125, crossing and extending a little beyond the ventral longitudinal excretory



TEXT-FIG. 12.—*Oligorchis hierticos,* sp. nov. *a.* Big and small rostellar hooks. *b.* Mature proglottis.

vessels. Cirrus well developed and spiny. Both seminal vesicles absent. Vas deferens specially developed, its coils usually extending to the aporal testis, sometimes beyond it. Testes, one aporal and anterior to the others, which are in a transverse row (posterior and lateral to ovary): in more

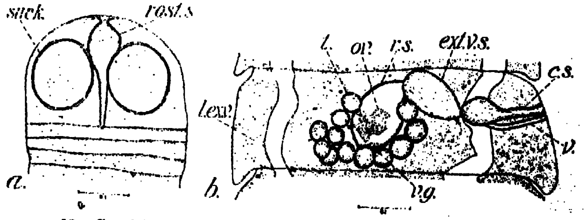
posterior segments all form a single row in contact with the posterior border of the proglottis. Uterus divided longitudinally into usually right and left sacs, often with a (comparatively much smaller) third between the two, containing 116-150 eggs.

From the present species, *Oligorchis paucitesticulatus* Führmann 1913 may be distinguished by the large number of testes, *O. yorkei* (Kotlan 1923) by the difference in number, size, shape and arrangement of the rostellar hooks while *O. toxometra* Joyeux and Baer 1928 and *O. strangulatus* Führmann 1909 are distinguished by the smaller size of the rostellar hooks, and their different shapes. Assuming the author's description to be accurate, *O. longivaginosus* Mayhew 1925 is to be distinguished by a characteristic division of the ovary into 4-6 knob-like lobes, a specially long vagina and the arrangement of the rostellar hooks in a single row and their uniform size.

Pseudoligorchis magnireceptaculata, gen. *et* sp. nov.

Host :—Bat.

Maximum length 76, maximum breadth 0·718 (gravid segment) and 0·638 (maximum width of the mature proglottis). In some strobilae, last but third or fourth segment gets reduced in width and the succeeding ones show further reduction till the last proglottis is reduced to 0·38 breadth. Scolex 0·318 maximum diameter. Rostellar sac embedded in the scolex, 0·067 diameter and 0·2 long. Rostellar hooks absent (the specimen were thoroughly examined in living state before fixation and the rostellar hooks were found completely absent). Genital pore unilateral, slightly anterior to middle of the proglottis margin. Genital cloaca absent. Genital ducts pass between the dorsal and ventral longitudinal excretory vessels. Cirrus sac 0·14-0·16×0·053, extending to ventral longitudinal excretory vessel, containing a fairly well developed external vesicula seminalis. Testes 8-12 in between the longitudinal excretory vessels and surrounding the ovary laterally and posteriorly, their number is usually greater on the aporal than on the poral side. Ovary with small irregular processes, in the middle of the proglottis. Receptaculum seminis large. Uterus an irregularly lobed sac, occupying the segment except the slight margin at the lateral sides.



TEXT-FIG. 13.—*Pseudoligorchis magnireceptaculata*, gen. *et* sp. nov. *a.* Scolex; *b.* Mature proglottis.

From the characters given, it is obvious that the above form must belong to Hymenolepidinae. Of the genera of this subfamily it is

clearly separated from *Aploparaksis* Clerc 1903, *Diorchis* Clerc 1903, *Hymenolepis* Weinland 1858 and *Oligorchis* Führmann 1906, by the number of testes, from *Diplogynia* Baer 1925 and *Diploposthe* Jacobi 1896 by its unilateral genital pores, from *Chitenolepis* Baylis 1923 (also from a mammal and with an unarmed rostellum) by the course of the genital ducts, lateral disposition of testes and the absence of the remarkably thickened outer shell of egg, from *Drepanidotaenia* Railliet 1892 by the lateral disposition of testes and the central position of ovary (never aporal), and from *Echinocotyle* Blanchard 1891 and *Hymenofimbria* Skrjabin 1914 by the absence of a sacculus accessorius and also of more than two longitudinal excretory vessels (as compared to the latter genus only).

I propose the name *Pseudoligorchis* for the new genus with the following diagnosis :—

Hymenolepidinae ; Scolex with an ? unarmed rostellum. Genital pore unilateral. Genital ducts pass between the longitudinal excretory vessels. Testes numerous (more than four) posterior and lateral to female glands. External vessicula seminalis present. Uterus an irregularly lobed sac.

Type-species.—*Pseudoligorchis magnireceptaculata*, sp. nov.

Including the form *Oligorchis hierticos* described above altogether seven species of *Oligorchis* Führmann 1906 have been recorded, all of which possess four testes except *O. paucitesticulatus* Führmann 1913, which has 7-11. Mayhew (1925, p. 37) is of the opinion that the presence of external and internal vesicula seminalis is comparatively unimportant and would therefore remove the species from Hymenolepididae. However, when the constancy of that organ in Hymenolepididae is considered, to dismiss it arbitrarily is unjustified and the writer is of the same opinion as Führmann, *i.e.*, that the form belongs to Hymenolepidinae. The constancy of the testes in that subfamily is a character on which the genera are founded, and there is no more reason for altering the diagnosis of the genus *Oligorchis* to 4-11 testes so as to include *O. paucitesticulatus*, than to alter it to 3-11 testes so as to include the genus *Hymenolepis* Weinland 1858 : excluding the species under discussion. the number of testes in both the genera is equally constant. *O. paucitesticulatus* is, therefore, transferred to the new genus *Pseudoligorchis*.

Family TAENIIDAE Ludwig 1886.

Taenia Linnaeus, 1758.

Taenia saginata Goeze, 1782.

Host :—Man.

Taenia hydatigena Pallas 1766.

Host :—Capra hircus.

Multiceps multiceps (Leske 1780) Hall 1910.

Host :—Ovis aries.

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REFERENCE LETTERS FOR THE TEXT FIGURES.

c. s.=cirrus sac ; *cirr.*=cirrus ; *ext. v. s.*=external vesicula seminalis ; *g. cl.*=genital cloaca ; *l. ex. v.*=longitudinal excretory vessel ; *mus. p.*= muscular pad ; *ov.*=ovary ; *r. h.*=rostellar hooks ; *r. s.*=receptaculum seminis ; *rost.*=rostellum ; *rost. s.*=rostellar sac ; *s. g.*=shell gland ; *suck.*=sucker ; *t.*=*testis* ; *v.*=vagina ; *v. d.*=vas deferens ; *v. ex. v.*= ventral excretory vessel ; *v. g.*=viteline gland ; *v. s.*=vesicula seminalis.

A FURTHER NOTE ON THE STYLE SACS OF GASTROPODS.

By R. V. Seshaiya, *Annamalai University, Annamalainagar, S. India.*

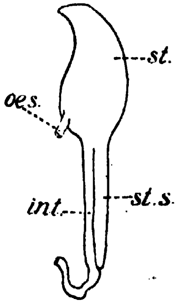
Yonge (9) recently compiled a list of forty one Gastropod genera, in which the style sac is known to occur. From this list *Ampullaria* has to be omitted, since Bouvier's record of a style sac in this genus has not been confirmed, particularly by the investigations of Prashad (5) who considers that the caecum in the Ampullariidae is not a style sac.

The present note records the presence of a style sac in five more genera, viz., (i) *Septaria* (ii) *Cyclotopsis* (iii) *Stomatodon* (iv) *Acrostoma* (v) *Tiara*. With the inclusion of these, the number of the Gastropod genera possessing a style sac comes to forty five, omitting *Ampullaria*.

In determining the presence of a style sac in the case of very limited preserved material one should look for two decisive features, the gastric shield and the epithelium of the style sac. In the case of the genera dealt with in this note, the material available for study was mostly limited and I have been guided by the above two features in arriving at my conclusions.

In the family Neritidae, a style sac was recorded by Lenssen in *Neritina*. Bourne (1) who described the anatomy of *Septaria* made no mention of a style sac in it. He found the stomach of *Septaria* to consist of a dilated oesophageal and a narrower pyloric moiety, but did not explain the relation of the latter to the intestine. He remarked however, about the presence of a thickened epithelial ridge, the "crete stomacale," in the stomach resembling the condition found in Gastropods with a crystalline style.

The shape of the stomach of *Septaria borbonica*, figured by Bourne (1) differs from that of *Septaria dravidica* [1] as will be seen from text-fig. 1. In *Septaria dravidica* the stomach is about 7 mm. of which the wider gastric portion is about 3 mm. and the narrower cylindrical part, about 4 mm. The gastric part is more than twice as broad as the pyloric portion. The latter consists of the style sac and intestine, which can be made out externally by the two longitudinal grooves separating them on the dorsal and ventral surfaces. In a transverse section, the style sac and the first part of the intestine are seen to be in "wide and open communication," being incompletely separated by the two typhlosoles. The style sac is twice as broad as the intestine. Its epithelium, which is thicker than that of the intestine, shows the usual features. The cells in the intestinal part are shorter and the cilia also are shorter. The minor typhlosole is a simple projection, whereas the major typhlosole is broad and shows

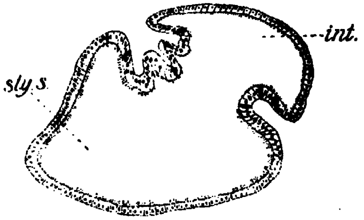


Text-fig. 1.—The stomach of *Septaria dravidica*. *int.* intestine in communication with the style sac; *oes.* oesophagus; *st.* posterior or gastric part of the stomach; *st. s.* style sac.

[1] *Septaria dravidica* Prashad, from Porto Novo, South India.

two grooves. Gland cells are especially abundant in the major typhlosole.

The style sac communicates by its entire length with the intestine. A gastric shield is present in the posterior chamber of the stomach and



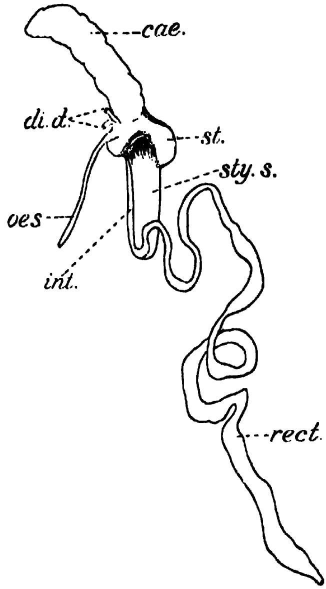
TEXT-FIG. 2.—Transverse section through the anterior part of the stomach (style sac and intestine) of *Septaria dravidica*. A few gland-cells are represented. Lettering as in fig. 1.

has the appearance of the "crete stomacale" described by Bourne (1) in *Septaria borbonica*.

The only terrestrical genus in which the style sac has been recorded till now is *Pomatias* (=*Cyclostoma*). Garnault's (2) observation recording the presence of a style sac in it was confirmed by Yonge (9). I find that *Cyclotopsis* also possesses a style and style sac. The stomach of *Cyclotopsis* differs to some extent in shape from that of *Pomatias*. It may be considered to comprise of three portions, a posterior caecum corresponding to the "cul-de-sac" of the stomach in *Pomatias*, a middle gastric portion and an anterior cylindrical part. The latter is what Garnault (2) termed the "intestine conoide" in *Pomatias*. He considered it as a part of the intestine. In *Cyclotopsis* it is composed of the first part of the intestine and the style sac, and may, therefore, be considered as the pyloric extension of the stomach, as in the case of the other genera possessing a style sac. The two parts, the intestinal and the stylar, can be made out externally. The intestinal part is whitish, narrow, and runs alongside of the wider greyish style sac. The pyloric part of the intestine is continued into the 'cylindrical part.' The presence of the intestinal and stylar portions was not described by Garnault (2) in the case of the "intestine conoide" of *Pomatias*.

In a transverse section of the anterior chamber or "intestine conoide", the style sac is seen as a wide circular chamber communicating with the small intestinal portion on one side. The communication between the style sac and intestine, which is wide in the upper part of the style sac, but narrower in the lower part, is bounded by the two typhlosoles. The typhlosoles present the features recorded in the other genera possessing a style sac. Gland cells are conspicuous on them, as also in the intestinal part of the anterior chamber. The style sac communicates by its entire length with the intestine. The epithelium of the style sac shews the usual characteristic features. The style, as made out in transverse

sections, consists of co-axial layers with a central core showing food particles consisting of vegetable matter. The animal is herbivorous, and in the laboratory was fed on bananas and moistened filter paper.



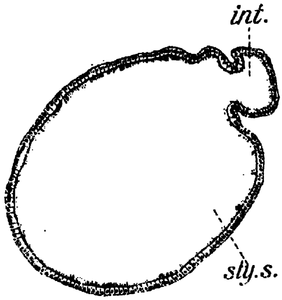
Text-fig. 3.—A partial dissection of the alimentary canal of *Cyclotopsis subdiscoidea.* *cae.* caecum of the stomach; *di. d.* ducts of the digestive gland; *int.* intestine in communication with the style sac; *oes.* oesophagus; *rect.* rectum; *st.* stomach; *sty. s.* style sac.

Sections through the middle chamber of the stomach showed the thickened cuticle in the form of a gastric shield. The cavity is usually filled with a large quantity of hard vegetable matter, and for sectioning, the chamber had to be slit open and cleaned of its food contents before clearing and embedding.

The style sacs of *Acrostoma, Tiara, Stomatodon* are of the type found in the other Melaniidae.

In this connection it may be pointed out that the structure of the style sac within the limits of a family is strikingly uniform. The only exception appears to be *Lithoglyphus* in which a style sac separate from the intestine was recorded by Von Ihering in 1885. I think it needs reinvestigation, as in other known members of the Hydrobiidae the style sac has a restricted communication with the intestine. As was pointed out by Yonge (9), the style sac cannot be of any taxonomic significance, but is correlated with the nutritional demands of the animal. As to the uniformity of structure within a family, it may be said that

the species of a family having a common structural potentiality can develop in response to their nutritional needs a common type of style sac.



TEXT-FIG. 4.—Transverse section through the anterior part of the stomach (style sac and intestine) of *Cyclotopsis subdiscoidea*. Lettering as in fig. 3.

Another point that may be referred to in this connection is the classification of the style sacs. More emphasis seems to have been laid by some authors on the width of the communication between the style sac and intestine, rather than on the length, as seen from the use of the expression "wide and open communication." The style sac, as in *Turritella*, may have a wide communication with the intestine and at the same time the communication may be *restricted*, extending only to a part of the length of the style sac. It seems better, therefore, to avoid the expression "wide and open communication" in the classification of the style sacs and use only the terms "free communication, restricted communication, and separate style sac" as Yonge (9) has done. The classification of the style sacs of Gastropods, as given by Mackintosh (4), may be re-stated as follows :—

Stage I.—(*a*) Style lying in the intestine or
(*b*) Style sac communicating by its entire length with the intestine.

Stage II.—Style sac communicating by part of its length. The communication may be wide as in *Turritella* or narrow as in *Mysorella*.

Stage III.—Style sac communicating by a small fraction of its length or quite separate.

In conclusion I have pleasure in expressing my best thanks to Dr. Baini Prashad for sending me some of the references and the specimens of Melaniidae referred to in this note, and for the identification of *Septaria dravidica*.

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ANATOMY OF *PALUDOMUS TANSCHAURICA* (GMELIN).

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INTRODUCTION.

The family Melaniidae, as usually constituted, consists of diverse forms whose anatomical relationships are imperfectly known. Moore (17) in his studies of the Molluscs of the Great African lakes described the anatomy of archaic forms like *Nassopsis* and *Bythoceros*. In the monographs of Bouvier (8), Bernard (7) and Perrier (20), anatomical accounts of particular systems of organs of some of the Melaniidae are referred to. Of no typical member of the family, however, whether foreign or Indian, a complete anatomical account has so far been published. For the Indian forms the only references available are the contributions by Annandale (2, 3) and Rao (26), and relate only to the radular or conchological features.

For the genus *Paludomus*, Ramanan (25) described briefly the habits of *P. tanschaurica*, and Annandale (2) figured the radula of *P. obesa* and commented on the distribution of the genus in India. The present paper gives a complete account of the anatomy of *P. tanschaurica*.

The genus *Paludomus* occurs in Ceylon, India, Malay Peninsula and Borneo. Preston (24) records thirty five species from the Indian Empire. *Paludomus tanschaurica* is found generally in clear, slow moving, shallow streams with a sandy bottom. The animals usually come towards the water-edge of the stream and extend the anterior part of the body out of water. The animals feel quite at home out of water for some length of time, and even crawl about outside water. When placed in a basin of water in the laboratory, they invariably climb the sides of the vessel and come to the water-edge with the anterior part of the body extended out of the shell, and some even crawl out of the water and lie outside. Fully grown specimens are met with in abundance usually in November and December. The shells in the adult specimens are usually found coated with encrustations of mud and algae and are then not easily distinguished from the surrounding algae that may be present in the water around them. In the hot season, when the stream dries up, the animals burrow into the mud. In the laboratory, specimens that had been kept outside water for two months easily revived when placed in water.

Ramanan (25) states that the species is 'oviparous' and I believe it is so, as I have not come across any evidence of vivipary in the animal.

THE ANIMAL.

The body of the animal, which consists of two and a half whorls, shows the usual divisions of the Gastropod body, head, foot and visceral mass. The head, foot and the mantle edge with its processes can be protruded out of the shell. When the animal actively moves about in water, the mantle processes are fully extended into the water and project forwards, but do not rest on the upper surface of the shell as in the

1

case of *Melanoides*. When the animal is out of water, the tips of the mantle processes project a little beyond the shell.

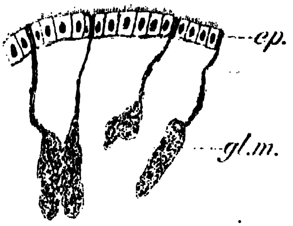
In the male the first and the second whorls have an orange brown colour, due to the presence of the testis on the dorsal and right lateral aspects. In the female specimens, the corresponding whorls are occupied by the ovary which is grey with interspersed yellow patches. On the convex side of the lower part of the second whorl the stomach is conspicuous. At the lower or anterior end of the penultimate whorl, to the left, is the pericardium,and behind it, the termination of the style sac is noticed as a circular translucent spot surrounded by glistening white connective tissue. Commencing at the apex of the body and extending to the right, and then alongside of the style sac, is the renal organ which is yellowish white in colour.

The mantle varies in colouration in the different parts. In the adult male the right side of the mantle enclosing the lower part of the genital duct is of an orange brown colour, while in the female the corresponding region is greyish white to creamy white in colour due to the conspicuous lower part of the oviduct. The mantle over the ctenidial region has a bluish-green appearance and the dorsal part of the stomach region also shows the same colour.

The Head.—The head projects forwards as the partly contractile snout, which, in the fully extended condition, measures about 3 mm. The head and snout are dark brown in colour with interspersed yellow spots arranged in transverse rows. The oral aperture is vertical and slit-like and situated at the anterior end of the snout. The tentacles measure about 6 mm. when fully extended, and are cylindrical and tapering at the tips. They bear the eyes on the outer side on slight lateral prominences. The tentacles are of the same colour as the snout.

The snout, in cross-section, is roughly semicircular in outline. The integument over the snout and the head consists on the outside of a layer of columnar cells with deep staining cytoplasm and round nuclei. The cytoplasm towards the distal ends of the cells is densely filled with brown pigment. Beneath the outer epithelium is a thick layer of transverse muscle fibres containing connective tissue between them. Underneath the transverse fibres are longitudinal fibres. On the sides of the head the longitudinal fibres are not confined to the lower part of the head but are present higher up also. Below the longitudinal fibres a few transverse fibres are again present. These different muscles bring about the elongation and contraction of the snout. The tentacle is covered by a columnar epithelium with unicellular mucous glands between the epithelial cells. The cells contain pigment and are similar to those found in the integument of the snout. The central part of the tentacle shows a more densely arranged connective tissue than that in the peripheral part lying under the epithelium, and contains several lacunae. The tentacular nerve and the tentacular blood vessel are seen in the centre. Underneath the general epithelium are circular muscles, and then come longitudinal muscles. Muscle fibres running across the tentacle from one side to the other are also present. The connective tissue cells are heavily pigmented like the epithelial cells.

The Foot.—The foot in its fully expanded condition measures about 12 mm. by 8 mm., and is somewhat triangulr in shape, but owing to its contractility, it often assumes an oblong or quadrate shape. On the ventral surface, near the anterior margin it shows a shallow transverse groove. The sole is of a light grey colour with interspersed yellow spots. The central region of the foot is of lighter hue than the peripheral. The operculum is carried by the foot dorsally about its middle, and the shell rests on the operculum when the animal is in progression. The foot, in its general structure is in no way specially modified. It is covered by columnar epithelium, which on the ventral surface is ciliated, while the main mass of the foot is composed of connective tissue and muscles, including longitudinal, transverse and vertical or dorso-ventral fibres. In the region of the anterior groove the cilia are longer. The pedal gland which is well developed is situated beneath the ventral epithelium and is composed of ovoid masses of gland cells with oval nuclei and long necks opening on the ventral surface. Each gland mass has the appearance of a multicellular gland of the saccular type, but is really a compact collection of unicellular gland cells. The narrow necks of the cells, as they develop and press forward to the epithelium, simulate the appearance of ducts. Anterior to the groove are more deeply staining, roundish cells with round nuclei and with their cell-details usually obliterated by the deep stain which they take up. As the cells develop they come up to open into the groove.



TEXT-FIG. 1.—The pedal gland-masses. *e. p.* ventral ciliated epithelium of the foot; *gl. m.* mass of gland cells.

The columellar muscle does not call for any remarks. A pseudo-epipodial flap forming a siphon, as in forms like *Viviparus*, *Pila* and *Mysorella*, is not present in *Paludomus*; but, the right side of the mantle opposite the terminations of the rectum and genital duct is produced into a short broad triangular spout-like structure.

THE MANTLE AND MANTLE CAVITY.

The mantle has the usual relationship to other organs and is better developed dorsally. Ventrally it unites with the foot leaving free a narrow fringe of about 0·5 mm.

The anterior part of the mantle is of interest in several respects. Immediately anterior to the termination of the ctenidium a vein runs transversely. This is the circum-pallial vessel or vena circularis. When the mantle is examined fresh, there is seen a heavily pigmented area in front of this vessel, extending for a distance of about 0·8 mm., and beyond it is a broad greyish white area appearing to be slightly thicker than the rest of the mantle edge. This corresponds in position to the supramarginal ridge of forms like *Viviparus*. Anterior to this greyish band, lies the free edge of the mantle or the mantle margin. The mantle

margin is ciliated and is about 0·2 mm. in width and slightly translucent in appearance in the living animal. In the position corresponding to the supramarginal ridge is a shallow groove, the supramarginal groove, but as will be shown later on, the differentiation of the mantle into a supramarginal ridge with a supramarginal groove in front of it, as seen in the Viviparidae, Ampullariidae and many other groups, is not properly discernible in the case of *Paludomus*. Blood vessels are seen ramifying in the pigmented area and communicating with the circum-pallial vessel.

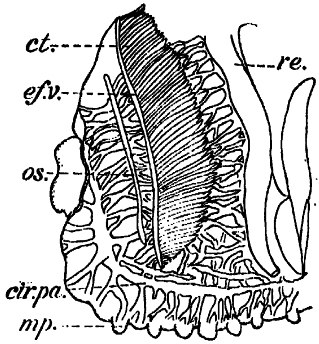
The most conspicuous feature of the mantle is the presence of the mantle processes. In very young specimens nine to twelve may be noticed, and in the adult specimens there are usually fifteen to twenty but the number sometimes goes up to twenty-three. The processes on the right side are usually closer to one another than those of the left side. They are of more or less uniform size unlike those of *Melanoides*. In the absence of grooves communicating with the supramarginal groove they differ from those of the Viviparidae. They differ also from the mantle processes of *Turritella*, which are grooved dorsally and are arranged in two rows.

In *Paludomus* the processes arise from the ventral surface of the mantle edge, and are, generally speaking, finger-like in outline. In the contracted condition they measure about 0·2 to 0·3 mm. and appear as oval structures with their long axes parallel to the mantle margin and are attached by stalk-like bases. When fully extended, they assume a more or less lanceolate shape. Observed in the living condition under the microscope, the mantle processes show a pellucid, peripheral portion and a densely pigmented central part. The pigment is light yellow in colour, seen by incident light under the binocular dissecting microscope. It is not uniformly dense in all processes; in some a few splashes are seen, sometimes none, while in others very dense lumps may be seen. The pigment is usually continuous with that of the basal part of the processes and that in the mantle also, but in some it may be discontinuous. Sometimes similar pigment is noticed in the mantle between the processes. Under high power the pigment appears in the form of a network of granules.

The Circulation in the Mantle.—The circum-pallial vessel receives small veins anterior to it. Posteriorly also there is a network of vessels communicating with it, and here and there are small veins having a course somewhat parallel to the circum-pallial vessel and communicating with it. Sinuses are present in the mantle processes also and they communicate with the circum-pallial vessel. Further details are dealt with under the circulatory system.

Histology of the Mantle processes.—In a vertical section passing through the mantle and the mantle process, the mantle process is seen as an anteroventral prolongation of the mantle. Its epithelium is continuous on the one hand with the epithelium of the ventral surface, and on the other with the epithelium of the mantle margin. It is composed of narrow columnar cells with prominent, elliptic to oval nuclei showing granular chromatin. The cells, especially towards the sides and the base, are ciliated. The distal ends of these cells show fine

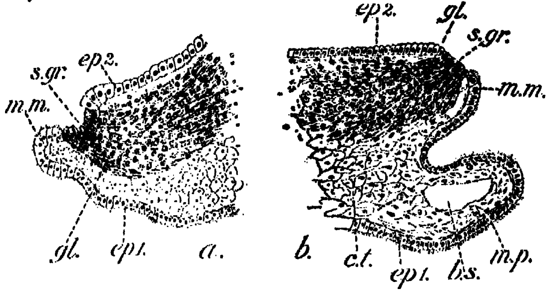
granules. Between the epithelial cells a few unicellular gland cells are seen. Each gland cell has a long narrow neck opening on the surface and a round swollen base containing an oval nucleus. The gland cells appear to be the same as those of the ventral epithelium of the mantle edge, and stain homogeneously. The thickness of the mantle process is composed of connective tissue and one or more sinuses. The pigment which is conspicuous in the living condition is not seen in sections.



TEXT-FIG. 2.—Circulation in the mantle. *cir. pa.* circum-pallial vessel; *ct.* ctenidium; *ef. v.* efferent ctenidial vein; *mp.* mantle process; *os.* osphradium; *re.* rectum.

The Histology of the Mantle.—The inner surface of the mantle in the anterior region is composed of columnar ciliated cells, among which are found unicellular mucous glands. The upper surface which is considered responsible for the secretion of the nacreous layer is composed of cubical or shortly columnar cells with large or rather oval nuclei. The anterior part of the mantle comprising of the mantle margin and the region of the supramarginal groove, in very young specimens differs to some extent from that of adult specimens. In the former, behind the mantle margin, there is a distinct groove and the epithelium behind it is slightly raised, being composed of cells a little taller than those of the remaining part of the outer epithelium of the mantle. The cells in the supramarginal groove are columnar and slightly compressed with large round, basally placed nuclei. They are similar to the outer epithelial cells of the mantle. Situated in the connective tissue of the mantle and extending a little backwards under the outer epithelium is the shell gland which is composed of elongate cells with large round nuclei containing granular chromatin. Generally, in the different families (Viviparidae, Ampul-lariidae) similar gland cells open behind the groove on the supramarginal ridge, but in *Paludomus* they distinctly open into the supramarginal groove. As in *Pila* and *Viviparus*, the gland consists of a mass of cells having narrow necks which reach out to the groove but are shorter than those in the Viviparidae.

In adult specimens, the region of the groove is very shallow and is not clearly seen. Its position is indicated usually by the break in the



TEXT.-FIG. 3.—*a.* Section through the mantle edge of an young specimen. ep_1. inner epithelium of the mantle; ep_2. outer epithelium; *gl.* shell gland: *m. m.* mantle margin; *mp.* mantle process; *s. gr.* supra marginal groove.

b. Section through the mantle edge and mantle process of an adult. *b. s.* blood sinus; *c. t.* connective tissue; ep_1. inner epithelium of the mantle; ep_2. outer epithelium of the mantle; *gl.* shell gland; *m. m.* mantle margin; *m.p.* mantle process; *s. gr.* region of the supra-marginal groove.

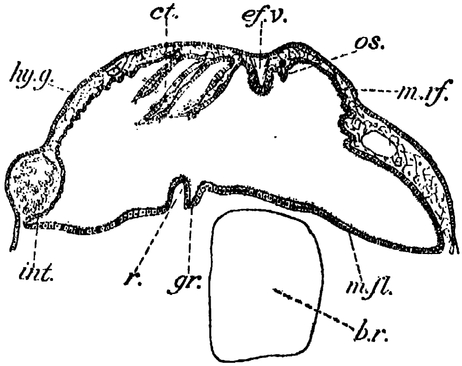
continuity of the dorsal epithelium and sometimes by a slight depression. Into this region the fibre-like necks of the shell glands open. The cells of the supramarginal groove, as seen in young specimens, are hardly distinguishable in the adult. In a large series of sections of the mantle edges of the adult examined by me, I found the shell gland present in a more or less well developed condition. The region immediately in front of the supramarginal groove is the mantle margin and consists of ciliated columnar cells.

The thickness of the mantle is composed of connective tissue, blood vessels and muscle fibres. The latter consists of longitudinal fibres beneath the epithelium, transverse muscle fibres and a few fibres running across the thickness of the mantle. The connective tissue cells are large and irregularly round and some of them contain calcareous concretions.

As to the function of the mantle processes, it is certain that they do not mould the sculpture of the shell as in the Viviparidae, the structure between the two being quite different. Further in *Paludomus* the processes are not embryonic structures as in many Viviparidae, but increase in size and number as the animal grows. In '*Melania*,' Benson (6) states that the processes clasp the right lip of the shell while the animal is crawling, and thus perhaps occasion the transverse furrows observable on the shell. In *Paludomus*, as seen already, the processes are more uniform and do not clasp the shell in the same manner as in *Melania*. But in the living animal they project beyond the shell and are turned up against the edge of the shell. If at all they can have any share in the formation of the sculpture of the shell, it can only be that, by frequent pressing against the edge of the shell as it is secreted, they

cause the lines seen on the shell, which, when examined under the lens, appear to consist of a series of minute elevations; but there is no exact correspondence between the mantle processes and the spiral lines which are about fourteen, the three central ones being prominent. The presence of definite sinuses in the processes in communication with the circumpallial vessel would show that the processes may function to some extent as accessory respiratory organs.

The Mantle cavity and the Pallial complex.—The floor of the mantle cavity shows on the right side a low ridge bounding on one side a slight depression or groove and extending from the apex of the mantle cavity to the region below the right tentacle. This ridge and groove are present in both the sexes and have no connection with the reproductive system like the genital grooves of the type which Moore (16)



TEXT-FIG. 4.—The mantle cavity (diagrammatic). *b. r.* buccal region; *ct.* ctenidium; *ef. v.* efferent ctenidial vein; *gr.* groove on the mantle floor; *hy. g.* mucous gland; *int.* intestine; *m. fl.* mantle floor; *m. rf.* roof of the mantle cavity; *os.* osphradium; *r.* ridge on the mantle floor.

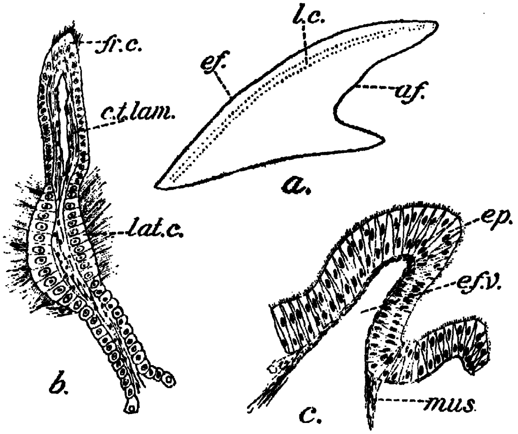
described in some of the Melaniidae. The position of the ridge and groove is similar to that of the food groove noticed by Yonge (33) in forms with ciliary feeding mechanism. but, as will be shown later on, there is no ciliary feeding in *Paludomus*. Sections through this region show the ridge to be a small, simple elevation of the mantle floor. In conjunction with the special ciliated epithelium at the base of the ctenidum, which will be described below, this ridge and groove may play some role in directing the water currents in the mantle cavity.

The pallial complex, as usual, consists of the osphradium, the ctenidium, the hypobranchial gland, and the lower part of the genital gland.

The osphradium is situated on the left side of the mantle cavity and is in the form of a simple, narrow ridge of more or less uniform width, and measuring about 3 mm.

The ctenidium is monopectinate and measures about 10 mm. It consists of about 200 lamellae. The lamellae in the middle region of the ctenidium are, as usual, of greater width than those towards either end of the ctenidium. Each lamella is attached to the roof of the mantle by its base and has a concave afferent side. The efferent side is longer than the base and measures about 2·4 mm., while the base measures only 1·8 mm. The region of specially well-developed cilia *i.e.* of the lateral cells is parallel to the efferent side.

A ctenidial leaflet is composed of a double layer of epithelium enclosing a blood space and a connective tissue lamella. In the latter, nuclei and muscle fibres are seen. At the apex of the leaflet the frontal cells are shortly columnar and ciliated, with large round nuclei. These gra-



TEXT-FIG. 5.—*a.* A single lamella of the ctenidium. *af.* afferent side; *ef.* efferent side; *l. c.* region of lateral ciliated cells.
b. Section through a single ctenidial lamella. *c. t. lam.* connective tissue lamella; *fr. c.* frontal ciliated cells; *lat. c.* lateral ciliated cells.
c. The mantle epithelium over the efferent ctenidial vein. *ef. v.* efferent ctenidial vein; *ep.* ciliated and glandular epithelium; *mus.* muscles.

dually pass down into the next part of ctenidium composed of shorter cells enclosing the efferent blood space. Below this is the region of the lateral cells with well-developed cilia. The cells are tall and columnar with large oval nuclei and the cilia are as long as the cells. The rest of the ctenidium is lined uniformly by somewhat cylindrical cells having among them ovoid gland cells.

The epithelium over the efferent ctenidial vessel is high and consists of columnar ciliated cells with rather distally placed nuclei. Between them are narrow gland cells with basally placed nuclei, and granular cytoplasm. Beneath the epithelium, longitudinal muscles and vertical muscles passing to the mantle roof are present. The contraction of these muscles probably helps the flow of blood. As to the function of the

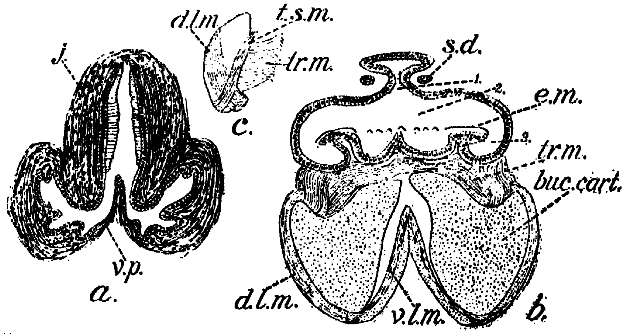
epithelium, it may be serviceable in directing the flow of the incurrent water. The mantle epithelium between the rectum and the ctenidium shows slight transverse folds and constitutes the mucous or hypobranchial gland. In this region the gland cells are numerous and globose and the depth of the staining they take depends on the amount of secretion in the cells. Between the mucous cells are columnar epithelial cells.

The general inner epithelium of the mantle is composed of short columnar ciliated cells with unicellular mucous glands between them. The gland cells are goblet shaped and differ from those of the hypobranchial gland in being of smaller size.

THE DIGESTIVE SYSTEM.

The food of the animal consists of diatoms and filamentous algae like *Spirogyra*. The feeding is by the radular mechanism.

The mouth is in the form of a vertical slit placed at the end of the snout. Bounding the mouth on either side there is an oval greyish coloured area which is smooth and cushion-like. The mouth is lined by columnar cells with oval nuclei and leads into the oral cavity or vestibule.



TEXT-FIG. 6.—*a.* Section through the region of the jaw. *j.* jaw; *v. p.* process of the ventral epithelium.

b. Transverse section of the buccal mass. 1. 2. 3. The three portions of the buccal cavity; *buc. cart.* buccal cartilages; *d. l. m.* dorsolateral muscles; *e. m.* elastic membrane; *s. d.* salivary ducts; *tr. m.* transverse muscle connecting the buccal cartilages; *v. l. m.* ventrolateral muscles.

c. Dissection to show the muscles of the buccal cartilages. *d. l. m.* dorso-lateral muscles; *t. s. m.* tensor superior muscle; *tr. m.* transverse muscle connecting the cartilages.

The oral cavity is surrounded by circular muscle fibres with connective tissue between them. The connective tissue is of the type found in the oral region of other Taenioglossates and which Bregenzer (9) termed labial cartilages in *Bythinella*. Muscle fibres run from the oral region to the dorsal and lateral regions of the snout. The appearance of the oral cavity as seen in section differs in the different parts. A little behind the mouth, the " vestibule " is seen to comprise of a central cavity produced into a dorso-median diverticulum and two ventro-lateral diverticula

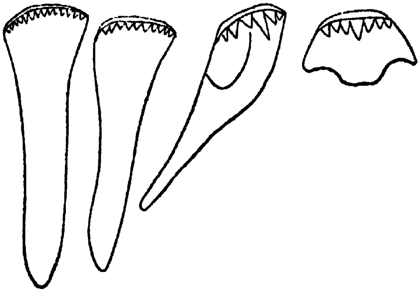
which are separated by a conical projection of the floor of the vestibule. A little further behind, about the commencement of the jaws, the ventro-lateral prolongations become reduced, while the conical projection of the floor assumes a dagger-shaped form in transverse section. The dorso-median chamber becomes prominent and its epithelium develops on its inner edge thick, cuticular plates which are continued into the jaws behind. The cells underlying the cuticular plates are columnar with elliptic nuclei, and show brown granules towards their free ends. In the region of the jaws the elevation on the floor of the cavity becomes still more pronounced and assumes a villus-shaped structure projecting half way into the dorsal diverticulum and the central cavity is drawn out laterally on either side. The jaws appear in transverse sections as chitinous rods in continuation of the underlying cells and are as long as the cells. Behind the jaws, the dorsal cavity becomes shorter and the oral cavity passes into the buccal cavity. In this region one can distinguish (i) a short median or dorsal unpaired cavity which is the continuation of the dorsal diverticulum of the oral cavity. Its roof shows two small lateral prolongations and its epithelium is ciliated throughout. (ii) The central cavity which has lateral expansions is flattened over the cartilages. (iii) In the posterior part of the buccal mass the ventro-lateral expansions of the buccal cavity dip beside the buccal cartilages. The floor of the central cavity shows two lateral elevations, one on either side, which are directed inwards and over which the elastic membrane is spread. The dorsolateral epithelium of the central cavity is composed of columnar cells with gland cells between them.

The buccal mass is pyriform and measures about 2 mm. Dorsally several fine strands of muscles arise from the anterior part of the oral tube and run to the dorsum of the snout. Some of these are median and others lateral. The anterior dorso-lateral muscles are represented by slightly thicker strands that arise laterally from the buccal mass about the region of the jaws. The posterior dorso-laterals are represented by two thick white strands arising from the sides of the buccal mass and several thread-like muscles arising more dorsally. The sphincter muscle, as usual, is developed in the anterior region of the buccal mass. The retractors of the buccal mass are club-shaped and arise laterally in the posterior part of the buccal mass about the level of the hind ends of the buccal cartilages. Ventrally a pair of ventro-median protractors are present arising at the hind end of the oral tube. A little behind these, the depressors of the radula arise and run down towards the region of the pedal ganglia.

The buccal cartilages are two in number, and viewed from the ventral surface, appear roughly oval in outline, but owing to a dorso-lateral depression in the anterior part, they appear as V-shaped structures in transverse sections of the anterior part. In the posterior part, the cartilages overlap each other partially. The structure of the cartilage is of the usual type, being composed of irregularly polygonal cells with faintly-staining, homogeneous ground substance, and with round deep staining nuclei situated close to the cell limits. The cell limits are distinctly stained. Towards the peripheral part of the cartilages the cells are small, and some of them possess two nuclei.

As for the muscles of the buccal cartilages, the condition presented by *Paludomus* differs from what has been described in forms like *Pila, Mysorella, Bythinella* and *Paludestrina*. Amaudrut (1) did not include the Melaniidae in his studies of the anterior part of the digestive tube of the gastropods. In a dissection of the buccal mass from the dorsal surface, after removing the superficial muscles, the radula and the elastic membrane, the buccal cartilages will be seen. Passing obliquely on the dorso-lateral surface of each cartilage is a band of muscle which runs forwards and inwards, and is attached to the elastic membrane. This corresponds to the tensor superior muscle. Underneath it is an oblique muscle, the dorso-lateral, running forwards and outwards from the posterior end of the cartilage. Posteriorly these muscles turn round to become continuous with those seen on the ventral surface, the ventro-lateral muscles. The ventral muscles run forwards on the inner surface of the cartilage. The transverse muscle connecting the two cartilages is a broad muscle arising from the dorso-lateral concavity of one cartilage and runs to that of the other and is therefore dorsal in position, though ventral to the dorsal muscles described above. In forms like *Pila* the muscle connecting the two cartilages is ventral in position.

The radula measures about 2·75 mm. It has the typical Taenioglossid formula 2. 1. 1. 1. 2 and bears about 130 transverse rows of teeth. The central tooth has a trapezoid outline, the anterior edge measuring 0·06 mm. and the posterior 0·09 mm., while the length in the antero-posterior axis is about 0·05 mm. The anterior margin, which is slightly reflexed downwards, bears one pointed conical, central denticle and three, sometimes four, smaller denticles on either side. The central denticle is stouter and more conspicuous than the lateral ones. The base of the



TEXT-FIG. 7.—The teeth of the radula showing the central, lateral and two marginals of one side.

central tooth is not straight but protrudes in the middle. The lateral tooth consists of a quadrilateral portion with its base prolonged on one side. The cutting edge bears one large denticle and three or more smaller denticles on either side. The outer and inner marginals are more or less similar, being somewhat spathulate in shape. The inner marginal bears ten small conical denticles. The outer marginal is slightly narrower than the inner marginal and bears twelve to sixteen denticles, sometimes even more.

In *Paludomus obesa*, the radula of which was figured by Annandale (2), the marginals have fewer denticles. The radula of *Paludomus tanschaurica* bears a closer resemblance to that of *Melania tuberculata*, the figure of which also was given by Annandale (2), in the marginals having small uniform denticles. The radula of *Paludomus* differs from that of *Acrostoma* in which the radular teeth are relatively shorter with fewer and blunt denticles. It differs also from that of *Nassopsis*, and less so from that of *Bythoceros* in which the shape of the central is different and the lateral has a shorter prolongation than in *Paludomus*.

The salivary glands are two long tubular and somewhat coiled structures. In preserved specimens they are usually found to extend as far as the region of the supra-intestinal ganglion. They lie close pressed to the sides of the oesophagus and in the region of the cerebral commissure lie under it. As they reach the buccal mass, the salivary glands pass into the salivary ducts which are narrower than the glands, and which taper towards their openings into the buccal cavity. The two ducts open on the dorsal surface into the buccal cavity, one on either side, about the middle of the buccal mass. The histological structure of the salivary glands of *Paludomus* agrees with that of Hydrobiidae, in having gland cells with support cells between them.

The oesophagus, on leaving the buccal mass, descends down to pass through the cerebral commissure, and is about 9 mm. long. The oesophageal epithelium has the usual histological features and is longitudinally folded. It has an investment of muscle fibres on the outside.

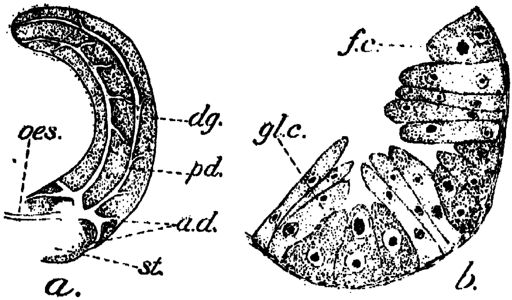
The oesophagus and the style sac are surrounded by a dense coating of a glistening-white connective tissue which shows effervescence on the addition of a drop of acid. The tissue consists of irregularly polygonal cells with feebly staining cytoplasm and deep-staining laterally placed nuclei. Some of the cells are large and possess calcareous concretions. When these are dissolved out as in the course of ordinary acid fixation, the cells appear full of of lacunae with thick walls.

The first part of the intestine has a well formed dorsal typhlosole besides finger-shaped processes. It has an investment of longitudinal and circular muscles. The rectum is much wider than the upper part of the intestine and its walls are thrown into prominent, longitudinal folds. A characteristic feature of the rectal epithelium is the abundance of goblet-shaped gland cells. After osmic fixation followed by iron haematoxylin, the cells show spherical basal nuclei and rows of dark spherical granules in the distal part. With ordinary stains the gland cells become deeply stained.

The disposition of the digestive gland has been described elsewhere. It consists of branched tubules or diverticula, from which small ducts arise. Those from the posterior part unite to form two long ducts running more or less parallel to each other from the apex of the body to the stomach. The main ducts from the anterior part are shorter and each posterior duct is joined by the anterior, so that there are ultimately two openings of the digestive gland into the stomach.

The tubules of the digestive gland, in cross section are roughly circular in outline and are bound together by connective tissue containing blood vessels. The tubules are composed of cells, which, by their

staining reaction and size, appear to be of two distinct kinds, the ferment cells and the gland cells. The ferment cells are ovoid, shorter, stouter



TEXT-FIG. 8.—*a.* The ducts of the digestive gland. *a. d.* anterior ducts; *d. g.* digestive gland; *oes.* oesophagus; *p. d.* posterior ducts; *st.* stomach.
b. Portion of a transverse section of the digestive gland. *f. c.* ferment cells; *gl. c.* gland cells.

and crowded between the gland cells, and do not usually reach the cavity of the tubule. They are deep-staining and have a cytoplasm showing a vacuolated appearance in osmic fixed material followed by staining in iron haematoxylin; the nucleus is spherical with a distinct nucleolus and is placed in the lower part of the cell. The gland cells are greyish and have a granular structure, the granules being abundant towards the free ends. They are cylindrical in shape, narrower and longer than the ferment cells and the nuclei are smaller. Both kinds of cells often show a large vacuole in the distal part. In the ferment cell the vacuole, when present, contains a number of small spherical bodies crowded together and dark brown in colour. In the gland cell the vacuole contains bodies which are light greyish brown and often in a state of disintegration or digestion. In some specimens especially in those infected with Trematode parasites, the cells of the digestive gland were found to be practically of uniform appearance, being of the type of the ferment cells. The nucleus, in almost all the cells, consisted of a clump of chromsomes and mitotic phases could be observed. Yonge (32) has shown that in Lamellibranchs the ferment cells are really the earlier stages of the gland cells and that they undergo division in the tubules. The same seems to be the case with the digestive gland of *Paludomus.*

THE CIRCULATORY SYSTEM.

The position of the pericardium has already been described. It is a triangular cavity bounded by the apex of the mantle cavity, the kidney and the style sac. There are no pericardial glands. The heart consists of a single conical ventricle and a somewhat oval auricle. The ventricle is thick and muscular, the muscles running from the base to the apex, from side to side, and obliquely as well as from back

to front. It has consequently a spongy appearance with a much diminished cavity. The auricle, as usual, is thin walled and less muscular and has a wider cavity. The muscles arising from the base of the ventricle are disposed to form a kind of valvular arrangement allowing blood to pass from the auricle to the ventricle but not the other way. The ventricle gives rise to a short truncus arteriosus which divides into an anterior artery and a posterior or visceral artery. At the base of the truncus arteriosus also, the muscle fibres are disposed to form a kind of valvular arrangement. The anterior aorta, after giving off a small artery, soon after its orgin, passes forward to supply the anterior part of the body and the foot. In its course it lies dorsal to the oesophagus, and anteriorly it gives off a branch to the foot, while the main branch passes beneath the radula to the buccal mass. The pedal artery runs dorsal to the pedal ganglion. The visceral artery runs on the dorsal side of the style sac, and proceeding further, gives off a branch to the digestive gland and another to the genital organ.

The venous system consists of a system of lacunae and is difficult to trace satisfactorily. The following appears to be the general course of the venous circulation. The genital gland and the digestive gland are situated in sinuses and the venous blood from the posterior parts of the body passes into the posterior sinus. Anteriorly the oesophagus and the anterior part of the alimentary canal lie in a sinus. The sinuses in the tentacles have been referred to already. The pedal sinuses run ventral to the pedal ganglia. The sinuses from the anterior parts of the body all unite into the anterior sinus. The anterior and the posterior sinuses unite ventral to the stomach to form the abdominal sinus. From the abdominal sinus some of the blood flows into the kidney from which a distinct renal vein passes to the base of the auricle into which it opens. The blood from the upper part of the intestine also passes through the abdominal sinus into the kidney.

The remaining part of the blood flows into the rectal sinus. The genital duct has under it a sinus into which also, some blood from the ventral or abdominal sinus seems to flow. From this sinus the blood flows into the rectal sinus surrounding the lower part of the intestine and the rectum. From the rectal sinus the blood flows along the roof of the mantle cavity into the ctenidial lamellae by a number of ramifications and from the ctenidium into the efferent ctenidial vessel. The efferent ctenidial vessel opens into the auricle at its base.

The pallial circulation, as stated already, is interesting. Bernard (7) did not study the Melaniidae, and of the forms he studied, *Natica* resembles *Paludomus* in the possession of a circum-pallial vessel but in other respects *Paludomus* is different. An examination of the fresh mantle or one fixed in formaline will show the distribution of the vessels. Arising from the lower part of the rectal region of the mantle is the circum-pallial vessel whose course has been described already. A number of sinuses are connected with it both in front and behind. Some of those in front communicate, as has been described above, with the sinuses in the mantle processes. The vena circularis or circum-pallial vessel runs to the left side and turns up where a number of sinuses from the left side of the body open into it. In this region a network of sinuses

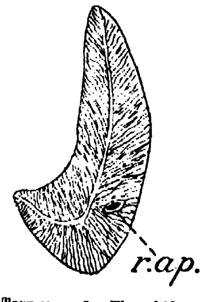
can be seen connecting the vena circularis with the efferent ctenidial vessel. Thus the blood from the circum-pallial vessel flows into the efferent ctenidial vessel. The appearance of this part of the pallial circulation is like that seen in the case of the Pulmonates. The habit of *Paludomus* in coming to the water's edge and keeping the anterior part of the body out of water is probably correlated, to some extent, with these peculiarities of circulation.

Several parts of the body, as noticed before, have a bluish green appearance and in the course of dehydration of fixed material, the alcohol is turned bluish-green, probably due to the presence of haemocyanin in the blood.

THE KIDNEY.

Perrier (20) made a passing reference to the kidney of *Melania* and said that it is a simple sac-like structure with its cavity obliterated by septa.

The renal organ of *Paludomus* is greyish or whitish yellow in the living condition. It is situated at the apex of the body whorl. Starting from the apex of the body whorl in front of the anterior end of the style sac, it passes up on the right side of the style sac as far as the posterior chamber of the stomach. Its anterior end projecting into the mantle cavity is roughly triangular in shape. The total length of the kidney is about 4 to 5 mm. and its greatest width is 2 mm., while in the narrow part extending alongside of the style sac it measures 1 mm.



TEXT-FIG. 9.—The kidney viewed from the ventral surface. *r. ap.* renal aperture.

The renal aperture into the mantle cavity is situated quite at the apex of the mantle cavity, more posteriorly than is usually the case. It is placed on the right side, on the ventro-lateral aspect of the ascending part of the kidney, close to the intestine. It is slit-like, and elliptic in outline. The pericardial aperture is much smaller than the pallial aperture and is placed on the pericardial aspect of the kidney. The intestine is placed dorsal to the kidney and is pushed down into it. In sections, this gives the appearance of the intestine being almost surrounded by the kidney.

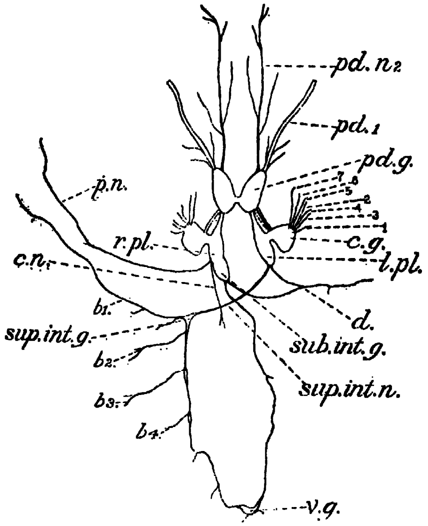
Internally the cavity of the kidney is traversed by numerous transverse septa. In a transverse section, the posterior part of the kidney lying between the style sac and the intestine appears roughly triangular in outline with the base being dorsal and the apex being near to the style sac. Running from the dorsal wall to the ventral are lamellae between which are blood spaces. Each lamella is composed of a double layer of renal epithelium enclosing a blood space. The renal cells are cubical with a homogeneous cytoplasm and usually vacuolated in the distal part. The nuclei are round and possess distinct, round nucleoli. In some of the cells, the nuclei are not seen.

The blood spaces in the lamellae communicate with the abdominal sinus surrounding the upper part of the intestine. The renal vein leaves the kidney ventrally in the anterior part. A blood-gland is absent.

The renal opening into the mantle cavity is lined by ciliated and gland cells and beneath the epithelium a well developed layer of muscles is seen. The reno-pericardial passage is lined by ciliated cells.

THE NERVOUS SYSTEM.

In the family Melaniidae, Bouvier (8) studied the nervous system of *Melania*, *Faunus* and *Melanopsis*. The study of the nervous system of *Paludomus* shows that it comes very close to that of *Melania* in all important features.



TEXT-FIG. 10.—The nervous system. 1 to 7. cerebral nerves; b_1. anterior branchial nerve; b_2, b_3, b_4. branchial nerves; *c. g.* cerebral ganglion; *c. n.* columellar nerve; *d.* dialyneury; *l. pl.* left pleural ganglion; *p. n.* pallial nerve; *pd. g.* pedal ganglion; pd_1 *n.*, pd_2 *n.*. dorsal and ventral pedal nerves; *r. p.* right pleural ganglion; *sub. int. g.* sub-intestinal ganglion; *sup. int. g.* supra-intestina ganglion; *sup. int. n.* supra-intestinal nerve; *v. g.* visceral ganglion.

The cerebral ganglia have a thick investment of connective tissue which has to be removed carefully in exposing them. They are oval in shape and their broad inner ends are united by a very short broad commissure. Each cerebral ganglion gives rise to seven nerves besides the nerve to the statocyst. The number, mode of origin and distribution of these nerves differs to some extent from what was described by Bouvier (8) for *Melania*.

(i) Arising dorsally from the outer lateral surface of the cerebral ganglion is a short slender nerve which proceeds to the side of the snout in front of the posterior retractor of the buccal mass. Bouvier (8) does not mention any such nerve in the case of any of the species of *Melania.* (ii) Anterior to this, arising dorsally from the anterior border of the cerebral ganglion, is a slender nerve, which, running forwards, divides into two branches and finally proceeds to the integument of the snout, in front of the tentacle. (iii) and (iv) Slightly posterior to the above nerve, arise the tentacular and ocular nerves which run more or less parallel to each other. The tentacular nerve is thicker than the ocular nerve and after passing into the tentacle, gives off a branch. (v) Slightly ventral to these, arises what may be called the proboscidian nerve which runs forward and divides into two branches proceeding to the dorsal part of the oral region. (vi) The next one is the labial nerve proceeding to the oral region. (vii) The ventral-most or innermost one is the buccal nerve which is well developed and fairly long. It gives off a labial nerve while the main nerve enters the buccal mass in front, and after giving off a small nerve to the anterior part of the buccal mass, runs backwards under the superficial muscles of the buccal mass and arrives in the buccal ganglion. The buccal ganglia are oval with their narrow ends connected by a fairly long commissure, and situated ventrally one on either side of the posterior part of the buccal mass. Each buccal ganglion gives off two nerves. The arrangement of the buccal connective is similar to the condition obtaining in *Melania* and *Cerithium.* (viii) The nerve of the statocyst arises close to and inside of the orgin of the cerebro-pedal connective. It is free throughout its course and runs between the crebro-pedal and pleuro-pedal connectives.

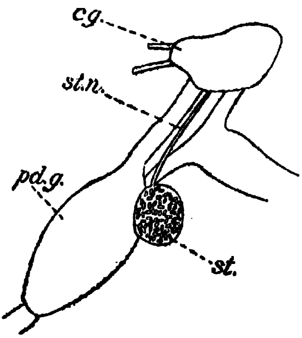
In the arrangement of the lateral centres *Paludomus* shows very close resemblance to *Melania.* The pleural ganglia are approximated to the cerebral, being connected to them by very short connectives, unlike the condition seen in *Melanopsis.* The right pleural ganglion is a somewhat spindle-shaped ganglion which gives rise to the supra-intestinal nerve and the right pallial nerve. The supra-intestinal nerve is a thick nerve which proceeds to the supra-intestinal ganglion. The left pleural ganglion is oval in shape and gives rise to two nerves (*a*) the left pallial nerve which proceeds to the anterior part of the mantle and (*b*) a slender nerve which runs down to the columellar muscle.

The sub-intestinal ganglion is in contact with the left pleural. Besides the right visceral nerve, it gives off a pallial nerve which proceeds to the right and joins the right pallial nerve from the right pleural ganglion, thus presenting a dialyneurous condition. The common nerve thus formed passes into the mantle on the right side and after giving off a branch proceeds to the genito-rectal region. This anastomosis differs from that seen in *Melania costata* and *M. tuberculata* in being much shorter and approaches the condition described for *M. amarula.* In fact, the anastomosis can be seen on opening the animal without much dissection.

The right visceral nerve has a slightly wavy course and in its course gives off one nerve. The supra-intestinal ganglion is triangular in outline and gives rise to two chief nerves, the 'anterior branchial' nerve

and the left visceral nerve. Close to its origin the anterior branchial nerve gives a fine branchial nerve and further on another slender nerve. After passing into the mantle it turns forwards and a fine nerve from the left pallial nerve runs towards this, but I have not been able to observe any anastomosis. The left visceral nerve is thinner than the right one and gives off three branchial nerves, the first one arising from it close to its origin from the supra-intestinal. Usually two small ganglia are seen in the course of the left visceral nerve. The visceral ganglion is slightly curved and situated close to the region of the renal aperture. It gives off two nerves one of which proceeds to the kidney.

The pedal ganglia are somewhat elongate and oval in shape and longer than the cerebral ganglia. The pleuro-pedal and the cerebro-pedal connectives are of moderate length, being much shorter than those of *Melanopsis* and slightly shorter than those of *Melania costata*. The two pedal ganglia are connected by a short narrow commissure situated in the upper part. The pleuro-pedal connectives are thicker than the cerebro-pedal. The pedal ganglia are produced into two thick ventral pedal cords which run to the posterior part of the foot. Close to its origin each pedal cord gives rise to two nerves, one on either side, and another nerve arises on the outer side a little further on. Arising dorsally and towards the inside of each pedal ganglion a thinner cord arises and runs parallel to its fellow. Each of these dorsal cords gives off a number of nerves but does not anastomose with its fellow. From the outer, lateral surface of each ganglion arises a short nerve to the sides of the foot. The pleuro-pedal cord close to its junction with the pedal ganglion, gives off laterally a short nerve.



TEXT-FIG. 11.—The statocyst and its nerve. *c. g.* cerebral ganglion; *pd. g.* pedal ganglion; *st.* statocyst with statoliths; *st. n.* nerve of the statocyst.

The statocysts are spherical and are situated in the upper part of the ventral surface of the pedal ganglion. The course of the nerve to the statocyst has already been described. The statocyst is spherical being about 0·3 mm. in diameter and is filled with numerous more or less oblong statocysts, the sides of which are slightly convex. The number

of statoliths varies in the family Melaniidae, as stated by Bouvier (8). In *Melania tuberculata, M. costata* and *M. amarula* according to Bouvier (8) the statocyst contains a single, round statolith. In *M. asperata* the statoliths are said to be numerous and so is the case with *Melanopsis*. In *Nassopsis* and *Bythoceros* also, the statocysts contain numerous statoliths. The statocyst in *Paludomus* is surrounded by connective tissue. Immediately outside the epithelium of the statocyst is a layer of muscle fibres. The epithelium consists of short cubical cells with large nuclei. Cilia could not be made out; however, some of the cells appeared to have short processes.

The structure of the eye is of the usual type and does not call for any remarks. The tentacles have already been described.

The general shape and position of the osphradium have been described already. The osphradium is placed over a nerve and consists of (i) sensory cells, (ii) gland cells and (iii) ciliated cells. The sensory cells are columnar and possess oval nuclei. The gland cells are of the usual type and found between the sensory cells. The ciliated cells are found towards the base of the osphradium on the lateral edges.

It now remains to consider whether the nervous system of *Paludomus* shows any relationship at all to that of the African Melaniidae described by Moore (17). There is practically no resemblance to the archaic condition seen in *Nassopsis*. As for *Bythoceros, Paludomus* shows some resemblance in the disposition of the cerebral ganglia, in the dialyneurous condition and in the approximation of the left pleural and the sub-intestinal ganglia. But the pleuro-pedal and the cerebro-pedal are shorter in *Paludomus* and the recurrent part of the buccal nerve passing to the buccal ganglion at the posterior end of the buccal mass is longer than in *Bythoceros*.

THE REPRODUCTIVE SYSTEM.

The reproductive system of *Paludomus* is peculiar among the Melaniidae and differs from what has been described in the other genera *Melania, Bythoceros, Nassopsis* and *Faunus*.

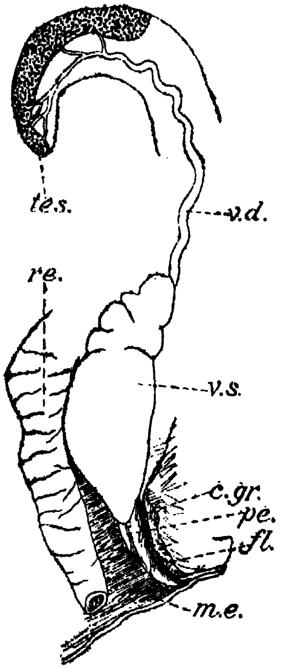
The animal is dioecious, but except for the slightly larger size of the body-whorl in the female, there is nothing to mark the sexes externally.

The Male Reproductive System.—The male reproductive system consists of the testis, the vas deferens, an enlargement of the vas deferens and the penis.

The testis is of an orange colour and occupies the dorsal and right lateral aspects of the first and second whorls of the animal and overlies the digestive gland. Anteriorly it extends very nearly to the posterior end of the stomach. It measures about 7 mm. in length and consists of tubular follicles. From these a few chief ducts arise and lead into the vas deferens which runs on the columellar side of the apical whorls. In its lower part which lies below the stomach, the duct becomes stouter and somewhat coiled.

On reaching the mantle cavity, the vas deferens presents an enlargement which may be termed the seminal vesicle. It opens anteriorly by a slit-like aperture which is bounded on one side by a flap extending beyond the genital duct for about 2 mm., *i.e.*, as far as the anal region

The area bounded by the flap is in continuation of the genital aperture and represents the vestigial, ciliated groove present in the reproductive

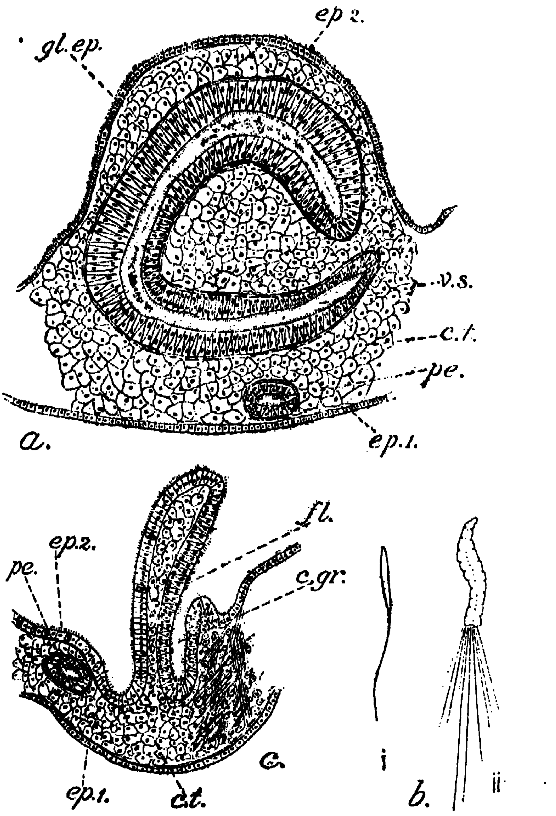


TEXT-FIG. 12.—Male reproductive system. *c. gr.* ciliated groove; *fl.* flap bounding the ciliated groove; *m. e.* mantle edge; *pe.* penis; *re.* rectum; *tes.* testis; *v. d.* vas deferens; *v. s.* seminal vesicle.

systems of the less specialised forms. The flap arises from the ventro-lateral edge of the enlargement of the vas deferens, or seminal vesicle. In the enlargement of the vas deferens two parts can be made out externally, an upper or posterior, triangular and comparatively thin-walled part measuring about 2 or 3 mm. and a lower thick walled portion about 4 mm. in length. From the posterior part of this enlargement of the vas deferens a long and slender tubular structure, the penis, arises, and after passing on it for some length, runs forward in the connective tissue of the mantle and lies on the rectal side of the genital duct. It tapers at its free end and measures about 4 to 5 mm.

The cavity of this lower part of the vas deferens is rendered crescentic in section owing to its wall being pushed in on one side. In the presence of this curious copulatory organ *Paludomus* differs from the other Melaniidae. Bouvier (8) states that he did not observe a penis in the Melaniidae studied by him, although Fischer had mentioned the presence

of a penis at the back of the tentacles. In *Bythoceros* the male genital duct is enlarged, but not like that seen in *Paludomus*, and the penis is absent. In *Nassopsis* the genital duct is simple and shows no modification in the mantle cavity. In the possession of the penis besides the genital aperture, *Paludomus* resembles *Typhobias*, but in the latter the penis is developed from the mantle and is muscular, according to Moore (15).



TEXT-FIG. 13.—*a*. Section of the male reproductive system through the seminal vesicle and penis. *c. t.* connective tissue; ep_1, ep_2. outer and inner epithelium of the mantle; *gl. ep.* glandular and ciliated epithelium of the seminal vesicle; *pe.* penis; *v. s.* seminal vesicle.

b. (i) eupyrene sperms; (ii) oligopyrene sperms.

c. Section through the male reproductive system in the region of the groove and flap. *c. gr.* ciliated groove; *c. t.* connective tissue; ep_1. outer epithelium of the mantle; ep_2. inner epithelium of the mantle; *fl.* flap; *pe.* penis.

The sperms are of two kinds, eupyrene and oligopyrene.' The eupyrene sperms measure about 14μ exclusive of the tail which measures about 26μ. The oligopyrene sperms measure about 20μ and bear a tuft of cilia, about ten in number and measuring about 40μ. The oligopyrene, when examined alive in fresh smear preparations, wriggle about.

The testis is covered by a single layer of cubical epithelium similar to and continuous with the general body epithelium. The investing epithelium consists of cubical cells with large oval nuclei. Beneath the epithelium are muscle fibres running transversely and underneath them lies connective tissue with blood spaces. The tubules of the testis lie in this connective tissue by which they are separated from one another. The tubules have a thin investment of connective tissue and their walls are composed of a protoplasmic layer in which nuclei of the sperm mother cells or spermatocytes are found. The spermatocytes develop into spermatogonia that project into the cavity of the tubule.

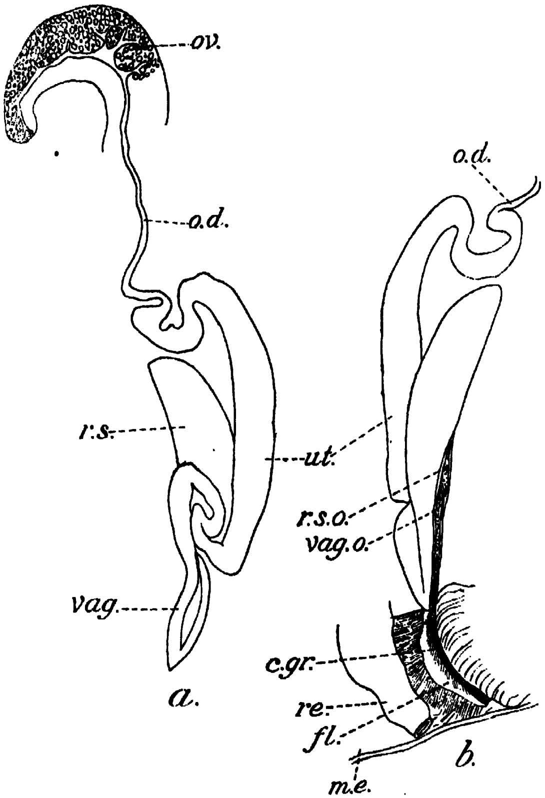
The vas deferens has an epithelium composed of cubical, ciliated cells, and is surrounded by muscle fibres.

The swollen part of the vas deferens or seminal vesicle lying in the mantle cavity has a thick investment of connective tissue in common with that surrounding the penis. The cavity of this enlargement is narrow and, as already pointed out, crescentic in section. The walls are thick and covered on the outside by muscle fibres. In transverse section the whole structure appears C-shaped and the narrow cavity is lined by ciliated and glandular epithelium. Owing to the presence of two kinds of cells, gland cells and ciliated cells, the nuclei appear at two different levels. The ciliated cells are narrow and possess oval nuclei which are rather distally placed, whereas the gland cells have basally placed nuclei. The penis, in transverse section, appears elliptic in outline. Its cavity is merely a narrow continuation of that of the enlargement of the vas deferens, and its histological structure is the same. The groove also is lined by ciliated and glandular epithelium continuous with that of the seminal vesicle. The flap guarding the groove is lined on the side facing the groove by glandular and ciliated epithelium continuous with that of the groove. The outer side is composed of epithelium continuous with that of the inner surface of the mantle.

The Female Reproductive System.—The female reproductive system consists of (i) the ovary (ii) the oviduct (iii) the uterus (iv) the vagina (v) the receptaculum seminis and (vi) as in the male, a flap guarding on one side a ciliated furrow.

The ovary occupies a position corresponding to that of the testis in the male. The colour of the ripe ovary is grey with interspersed yellowish. circular patches. The ovary is a racemose structure consisting of much branched tubular follicles, from which small tubules arise and lead into about seven or eight larger ducts which finally join the oviduct. The lower or the anteriormost duct is stouter than the others and receives four smaller branches. The oviduct runs on the columellar side of the digestive gland and the stomach, and on entering the mantle cavity, enlarges into the thick walled uterus. The oviduct is about 4 or 5 mm. long and yellowish in colour. The lower part of the female genital duct

lying in the mantle cavity is peculiar. The uterus in its lower part turns up to take a sharp bend and after once more becoming doubled on itself

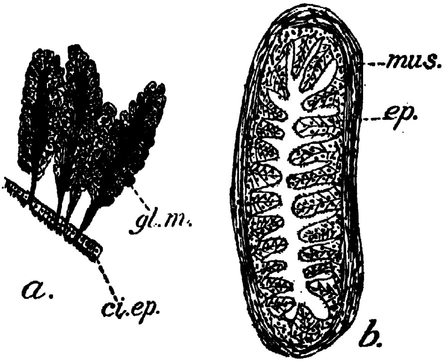


TEXT-FIG. 14.—*a.* Dorsal and *b.* ventral views of the female reproductive system. *c. gr.* ciliated groove; *fl.* flap.; *m. e.* mantle edge; *o. d.* oviduct; *ov.* ovary; *re.* rectum; *r. s.* receptaculum seminis; *r. s.o.* opening of the receptaculum seminis; *ut.* uterus; *vag.* vagina; *vag. o.* vaginal opening.

passes into the vagina. The vagina is oval in outline. Lying in the same plane as the uterus and vagina, there is a roughly triangular thin walled sac which appears to be a receptaculum seminis and not a brood pouch. The internal structure and the absence of any traces of embryos in the numerous specimens examined by me lead me to consider this sac a receptaculum seminis. The receptaculum seminis and the vagina open into a kind of furrow guarded by a flap extending, as in the male, for a length of about 2 mm. in front of the vagina. The flap extends from

the surface of the vagina and is continuous with the spermatheca also. The uterus is about 5 or 6 mm. in length and has thick glandular walls. The walls of the vagina and the uterus develop a creamy-white colour in mature specimens, which is seen conspicuously on the outer surface of the mantle.

The ovary is covered by a thin epithelium which is a continuation of the general body epithelium and underneath this there is connective tissue. The follicles which are roughly oval in section consist of a thin germinal epithelium from which ova in different stages of growth project into the cavity of the follicle. The ripe oogonia are found filled with yolk. The oviduct is lined by columnar ciliated cells. The cavity of the uterus also is lined by columnar ciliated cells. The thickness of the uterine wall in the upper part is composed of elongate saccular gland masses composed of groups of cells with ill defined cell-limits and round nuclei. These glands open between the epithelial cells into the cavity of the uterus. In the lower part of the uterus and the vagina, the walls, as already stated, have a creamy white colour, and the histological structure, though really the same as that of the upper part of the uterus presents often a different appearance. The cavity is roughly U-shaped. One limb of the U-shaped cavity develops in its walls, on either side, glandular tissue similar to that seen in the upper part of the uterus, but deep staining and with cell details obliterated. The gland masses open by narrow necks between the ciliated cells. Each gland mass consists of gland cells arranged round a central lumen and appearing like saccular glands opening into the uterine cavity between the epithelial



TEXT-FIG. 15.—*a*. The gland-masses of the vaginal wall. *ci. ep.* ciliated epithelium; *gl. m.* gland mass.
b. Section through the receptaculum seminis. *ep.* epithelium; *mus.* muscle.

cells. The other limb of the cavity is usually not invested with glandular tissue. This condition is similar to what I described in ***Mysorella***. The inner side of the flap, and the groove are lined by an epithelium continuous with that of the vagina.

The receptaculum seminis, has a characteristic appearance in section. It has an investment of muscle fibres and its epithelium is thrown into finger shaped processes and is composed of columnar, glandular and ciliated cells, with basally placed nuclei, and with cytoplasm staining light pink with eosin. The ciliated cells seem to become transformed into the gland cells by the loss of the cilia. A brood pouch, as described for *Melania*, is not found in *Paludomus*. I examined a very large number of specimens in the different seasons of the year and no trace of 'vivipary' could be found. The species seems to be oviparous as Ramanan (25) has recorded.

The above account of *Paludomus* will show that its reproductive system is unlike that of any other genus in the Melaniidae, so far as is known to us. *Paludomus* has to be considered as a specialised form. The open groove present in the less specialised forms like *Melania episcopalis* as described by Moore (16) is indicated in *Paludomus* by the very short furrow, guarded by a flap extending anteriorly for a distance of 2 mm. from the genital aperture.

Summary and Conclusion.

1. The complete anatomy of *Paludomus tanschaurica* is described.
2. The foot possesses a well developed pedal gland.
3. The structure of the mantle and the mantle processes is described.
4. The mantle processes, which are present, do not have the same function as those in the Viviparidae. No function is definitely assigned to them, but the presence of the sinuses would show that they may subserve as accessory respiratory organs.
5. The shell secreting region of the mantle differs from that of the Viviparidae in one respect. The shell gland does not open on a supramarginal ridge but into the supramarginal groove which is found fairly well developed only in young animals.
6. The mantle floor shows a low ridge on the right side bounding a shallow groove and running from the apex of the mantle cavity to the right tentacle. The epithelium over the efferent ctenidial vessel is peculiar in being high and composed of well developed gland cells and ciliated cells. The ridge and this epithelium may be useful in directing the currents of water.
7. The buccal cartilages are connected *dorsally* by a broad transverse band of muscle.
8. The radula resembles in the nature of its marginals that of *Melanoides tuberculata.*
9. The salivary glands are fairly long, coiled, simple tubular structures.
10. The digestive gland shows two types of cells, the gland cells and the ferment cells, according to their staining reaction. The ferment cells undergo division in the tubules, and in some specimens, especially in those infected with parasites, all the cells of the digestive diverticula are uniformly made of ferment cells. It is quite probable that, as in Lamellibranchs, the ferment cells represent a stage in the development of the gland cells.

11. The pallial circulation in the anterior part of the mantle is interesting in the presence of a circumpallial vessel receiving a ramification of vessels in front of, as well as behind it, and communicating on the left side with the efferent ctenidial vessel.

12. The renal organ is a simple sac-like organ with its cavity traversed by transverse septa.

13. The nervous system resembles in general that of *Melania* in being dialyneurous, in the approximation of the sub-intestinal ganglion to the left pleural and in the nature of the buccal nerves.

The general tendency in *Paludomus* is towards greater concentration. The statocyst contains numerous statoliths unlike the statocysts of *Melania tuberculata, M. amarula,* which, according to Bouvier (8) have a single statolith.

14. The reproductive system does not resemble that of any other Melaniid described so far. The male reproductive system is interesting in having (*a*) an enlargement or seminal vesicle in the mantle cavity, (*b*) a slit-like aperture and (*c*) a flagellum-like penis. The sperms are of two types, eupyrene and oligopyrene. The female reproductive system possesses a uterus and vagina with glandular walls and a receptaculum seminis. There is no brood pouch as in *Melanoides.* In both sexes there is a short furrow of about 2 mm. guarded by a flap leading from the genital aperture to the mantle edge. This is the vestigial form of the ciliated groove found in the less specialised types of reproductive system.

15. The animals withstand dessication in the laboratory for over two months.

This account of *Paludomus tanschaurica* will show that its resemblances are to *Melania* especially forms like *Melanoides tuberculata* and *Melania amarula.* The resemblances are chiefly with reference to the nervous system. With regard to the reproductive system *Paludomus* stands by itself and shows features of specialisation in both sexes in the development of accessory structures.

In conclusion I have to express my best thanks to Dr. Baini Prashad for encouragement and the interest he has taken in the progress of my work.

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NOTES ON THE BIONOMICS OF *TROCHUS NILOTICUS* LINN.[1]

3. SUR UN COPÉPODE PARASITE DE *Trochus niloticus*.

Par THÉODORE MONOD, *Docteur ès-sciences, Museum National d'Histoire Naturelle, Paris.*

Panaietis incamerata Stebbing 1900.

1900. *Panaietis incamerata, Stebbing, Willey's Zoological Results*, V, pp. 666, 667, pl. lxx, fig. E.
1932. *Panaietis incamerata*, Monod et Dollfus, *Ann. Parasitol.* X, p. 157, fig. 17 A.

Localité.—3 ♂, 21♀. dans la cavité buccale et l'oesophage d'un gastéropode, *Trochus niloticus* Linné, à Port Blair, Iles Andamans, Septembre 1932—Mars 1933. Ces specimens m'ont été très obligeamment communiqués par Mr. Robert Gurney, auquel ils avaient été envoyés par le Dr. Baini Prashad, de l'Indian Museum. Je remercie vivement Mr. Robert Gurney de m'avoir ainsi permis l'étude d'une espèce intéréssante et mal connue ainsi que le Dr. Baini Prashad pour l'hospitalité qu'il a bien voulu accorder à cette note dans les *Records of the Indian Museum.*[2]

Habitat.—L'unique exemplaire (♀) dont avait disposé Stebbing provenait de la cavité palléale d'un gastéropde indéterminé de Panaieti, Archipel de la Louisiade. La redécouverte de l'espèce aux Iles Andamans permet de donner une deuxième localité et de préciser l'identité de l'hôte, ou peut-être de l'un des hôtes seulement.

Remarques sur le genre Panaietis.—Sur la foi des documents publiés, très sommaires puisque les pièces buccales de *Panaietis* ne sont pratiquement ni décrites ni figurées par Stebbing, nous avions, R. Ph. Dollfus et moi, avoué récemment "l'impression" (1932, p. 156) que *Panaietis* Stebbing 1900 et *Conchocheres* G. O. Sars 1918 étaient synonymes. L'examen des spécimens andamans de *Panaietis incamerata* infirme notre supposition et nous oblige à restituer le genre *Panaietis*, dont la ♀ porte des maxillipèdes développés, à la famille des Lichomolgidae, tandis que *Conchocheres*, à ♀ sans maxillipèdes, demeure dans la famille des Clausiidae.[3]

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[1] The second Note of this Series was published in *Rec. Ind. Mus.*, XXXVI, pp. 1–4 (1934).

[2] 15 specimens (14 ♀, 1 ♂) ont été retournés à l'Indian Museum, 1♀ a été déposée au British Museum (Nat. Hist.), 1 ♀ chez Mr. Robert Gurney et 7 exemplaires (5 ♀, 2♂) ont été conservés à Paris.

[3] Cette famille, très mal definie, n'est peut-être pas une groupe naturel. Si l'absence de maxillipède chez la ♀ n'est qu' un caractère générique, et si *Myicola* peut vraiment trouver place, comme le veut Wilson (1932, p. 346), dans les Lichomolgidae, il n'est pas invraisemblable que *Clausia* et *Conchocheres* ne puissent au jour en faire autant et qu'il faille—le jour où ces genres seront mieux connus considérer *Trocheres* Pelseneer, et même *Strongylopleura* Pelseneer et *Ischnurella* Pelseneer comme des Lichomolgidae, vaste groupe sans doute infiniment plus polymorphe et plus difficile à définir qu' on ne l'a cru jusqu' à présent, alors qu'on n'avait affaire qu'aux genres typiques, plus ou moins cyclopoides. J'ajoute que le rapprochement de *Conchocheres* et de *Mytilicola-Trochicola* (Monod et Dollfus, 1932, p. 164) ne saurait être que provisoire et ne survivrait pas, bien entendu, à une absorption des Clausiidae (*sensu* G. O. Sars) par les Lichomolgidae.

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Stebbing avait, à très juste titre (1900, p. 666) reconnu que son genre *Panaietis* était voisin d'*Anthessius* Della Valle et de *Paranthessius* Claus.

Remarques sur Panaietis incamerata.—La diagnose originale et les figures qui l'accompagnent étant incomplètes, parfois erronées, et ne concernant d'ailleurs qu'un des sexes, il m'a semblé utile de donner quelques dessins précis et une description sommaire de l'espèce.

Taille: 7 (♂) à 9 (♀) millimètres. *Corps* allongé, étroit, vermiforme légèrement dilaté dans la région céphalique, environ 5 fois plus long que

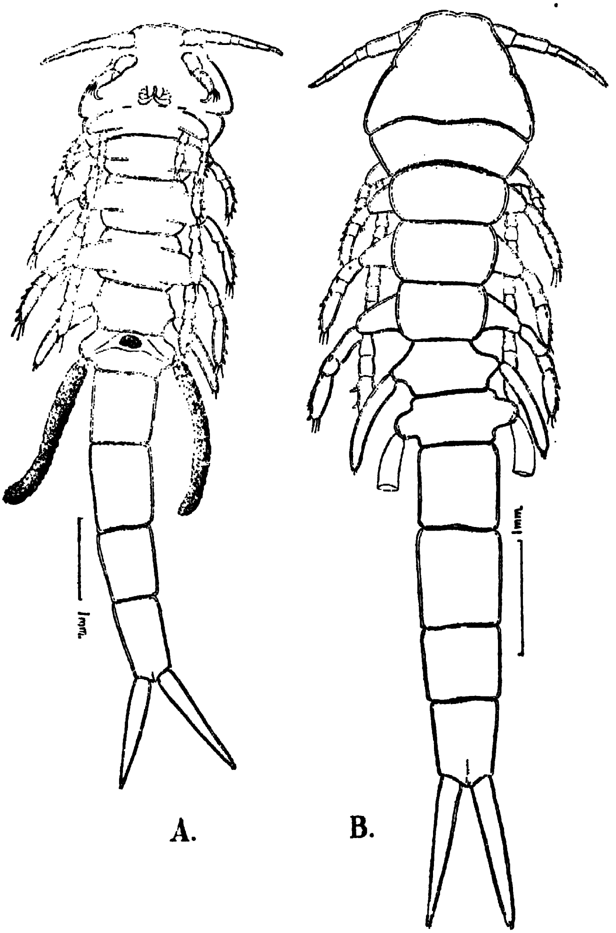

FIG. 1.—*Panaietis incamerata* Stebbing, A. B. ♀, ♀.

large (largeur maxima au bord postérieur de céphalon). Céphalon très court (env. 9 fois dans la longeur totale), notablement plus large que long, largement arrondi au bord frontal, à bord latéraux convexes, à bord postérieur subdroit. *Thorax* (env. $3\frac{1}{2}$ dans la long. tot.) à 5 somites pédigères libres, de largeurs décroissantes de I à IV, à bords latéraux légèrement et régulièrement convexes; V avec une saillie latérale marquée (insertion de la 5^{e} patte). *Abdomen* long (3/5^{e} de la long. tot. environ), très étroit, 5-articulé dans les 2 sexes; somites II-V à bords rectilignes, sensiblement parallèles, sauf au V où les bords latéraux convergent un peu rostro-caudalement; segment génital ♀ très court, avec des lobes

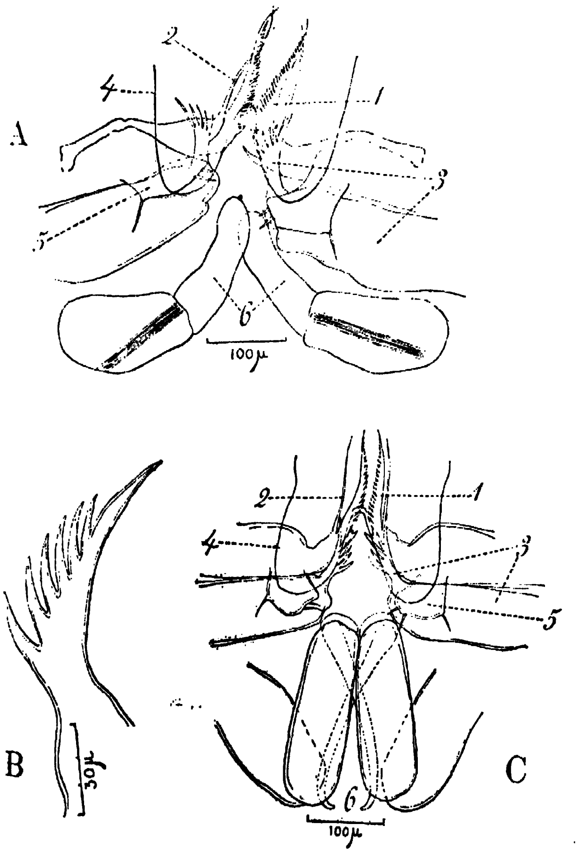

FIG. 2.—*Panaietis incamerata* Stebbing. *A.* ♀, pièces buccales; *B.* apex maxillaire; *C.* ♂, pièces buccales, 1. division interne et principale de l'apex mandibulaire; 2. division externe et accessoire de cet apex; 3. maxille; 4. labrum; 5. maxillule; 6. maxillipèdes.

latéraux hémisphériques[1] très saillants, le même segment proportionnellement plus long chez le ♂, à bords latéraux simplement convexes, avec 2 sétules aux angles caudo-latéraux, branches furcales longues (env. 1/6 de la long. tot.) simples, digitiformes, 6-7 fois plus longues que larges, terminées en pointe obtuse portant 4 sétules. *Antennules* normales, 7-articulées, sétigères. *Antennes* 3-articulées[2], trapues

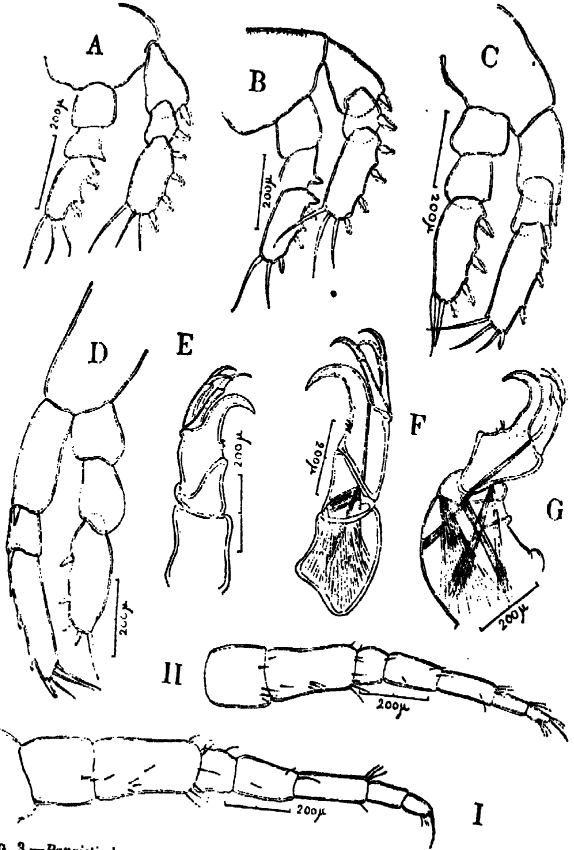

FIG. 3.—*Panaietis incamerata* Stebbing. ♂, *A-D*. pattes thoraciques i-v ; *E*. antenne ♂ ; *F*. antenne ♀ ; *G*. antenne ♂ ; *H*. antennule ♂ ; *I*. antennule ♀.

[1] C'est par erreur que Stebbing (1900, p. 666) considère les saillies latérales du segment génital comme appartenant à la base d'un très long " premier " somite abdominal.

[2] Stebbing se trompe en donnant l'antenne comme 2-articulée (1900, p. 666, pl. lxx, fig. E *ai*, où le " muscle " est en réalité une limite articulaire) et Wilson, reproduisant cette erreur, place *Panaietis* (entrée 2/71 de la *Key to the genera of the suborder Cyclopoida* 1932, p. 583) dans les genres à antenne 2-articulée.

préhensiles ; 3e- article portant 3 très petites sétules internes, une très puissante griffe et, extérieurement à celle-ci, 3 griffes beaucoup plus grêles. *Labrum* profondément bilobé, à lobes entiers et inermes. *Mandibule* bifide, étant terminée par une lame pectinée effilée et un flagelle accessoire, paraissant inerme et aussi long que la lame principale ; quelques denticules plus forts à la base de la partie régulièrement pectinée de celle-ci. *Maxillule* trapézoidale, portant 3 sétules (1+2). *Maxille* terminée par un processus robuste portant 6-7 fortes épines. *Maxillipède* apparemment 2-articulé et inerme (chez la ♀, 3-articulé, et préhensile, avec un long dactyle falciforme portant 2 sétules à la base, chez le ♂).

Pattes thoraciques I-IV à 2 rames 3-articulées ; chétotaxie (les épines sont des épines à frange et les soies sont glabres) : I, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. +3 soies apicales ; endopodite : art. 1, inerme, art. 2, inerme, art. 3, 2 épines ext. + 3 soies apicales. II, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. + 3 soies apicales ; endopodite : art. 1, inerme, art. 2, inerme, art. 3, 3 épines ext. + 2 soies apicales. III, exopodite : art. 1, 1 épine ext., art. 2, 1 épine ext., art. 3, 4 épines ext. +2 soies apicales. IV, exopodite : art. 1, 1 épines ext., art. 2, 1 épine ext., art. 3, 4 épines ext. 3 soies apicales ; endopodite : art. 1, inerme, art. 2, inerme, art. 3, 4 épines ext. 1 soie apicale. Les seuls différences entre le ♂ et la ♀ concernent les pattes I et II qui ont, chez le ♂, 3 protubérances coniques supplémentaires au bord externe de l'endopodite (1 àl' article 2, 2 à article 3). *Patte thoracique* V grêle, cylindroide, étroite, env. 6-7 fois plus longue que large, légèrement arquée et entièrement glabre, à l'exception de l'apex, muni de 2 spinules et d'une sétule. *Sacs ovigères*, en cordons

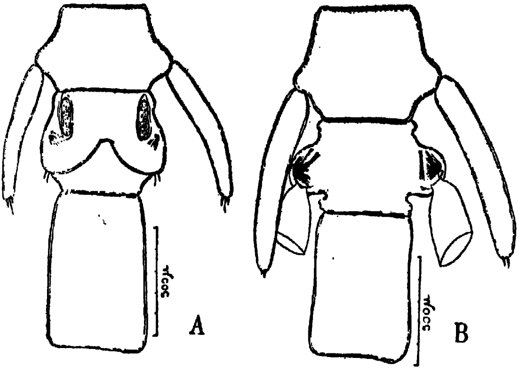

FIG. 4.—*Panaietis incamerata* Stebbing. A. ♂ 5e somite thoracique, segment génital et 2e somite abdominal ; *B.* ♀, *id.*

grêles, à oeufs multisériés, plus ou moins longs, pouvant atteindre presque l'extrémité caudale mais ne semblant jamais la dépasser.

Anatomie interne : réceptacle séminal ovalaire ou globuleux, allongé transversalement, ne dépassant pas, ou à peine, en avant, la limite du

segment génital; ovaire céphalique, paraissant entièrement double; oviductes pénétrant parfois dans la base des pattes.

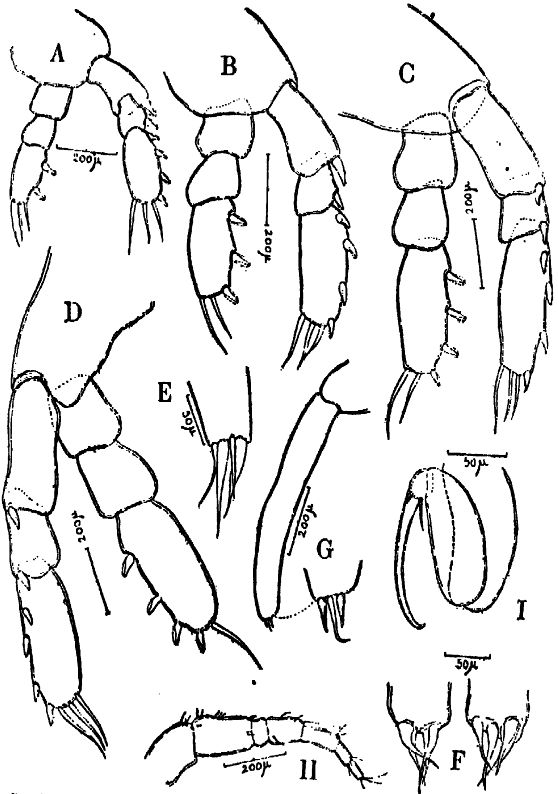

FIG. 5.—*Panaietis incamerata* Stebbing. *A-D.* ♀, pattes thoraciques i-v; *E, F.* id., extrémités de branches furcales; *G.* 5ᵉ patte thoracique ♂; H. antennule ♀ *juv.*; *I.* maxillipède ♂.

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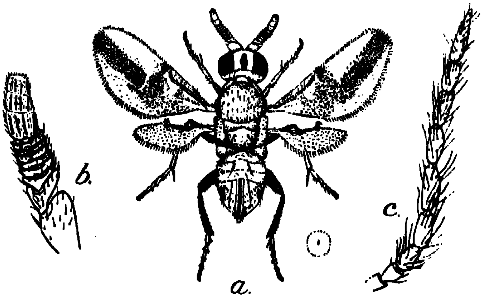
FIRST RECORD OF THE CHALCID GENUS *COMPERIELLA* HOWARD FROM INDIA WITH A DESCRIPTION OF A NEW SPECIES.

By T. V. RAMAKRISHNA AYYAR, *B.A.*, *Ph.D.*, *Madras Agricultural Department, Coimbatore.*

The genus *Comperiella* was established by L. O. Howard (3) in 1906 to include an extremely interesting Chalcid wasp collected by the famous parasite hunter George Compere from China, with *C. bifasciata* as the type-species. Since then three more species of this genus have been described: *C. pia* from Australia by Girault in 1915, *C. cerapterocera* by Mercet from Spain in 1921 and *C. unifasciata* by Ishi from Japan in 1925. The genus has not been recorded from India so far. A couple of years ago, while engaged in bionomic and systematic studies on South Indian scale-insects and their parasites, the author came across a wasp bred from a diaspine scale-insect which on examination was provisionally regarded as a *Comperiella*. For want of time and sufficient material at the time further examination of the insect was left in abeyance though a record of it was included in the author's bulletin (1) on Coccidae in 1930. Recently the study was taken up on further material becoming available and on comparison with the description of the three previously recorded forms the Indian form was found to belong to a new species; this was confirmed by an authority on the group, Mr. H. Compere of California, who recently visited Coimbatore. The species is described below under the name *C. indica*, sp. nov.

Comperiella indica, sp. nov.

Female (text-fig. *a*) length from head to tip of abdomen 1·034 mm.; including the wing which extends behind body 1·43 mm. General



Comperiella indica sp. nov.
a. Complete insect, female, seen from above.
b. Antenna of female.
c. Antenna of male.

colour light to dark brown. Eyes dark; funicular joints of antennae and dorsolateral region of base of abdomen deep brown. In certain lights the frontovertex between the eyes shows a shining creamy colour with a narrow, long brown streak over the ocellar region behind; the median region of the pronotum shows a similar shining patch and the mesoscutum is iridescent with a greenish metallic colour. Ocelli with some reddish pigment. Legs—in the two front pairs of legs, femora, extreme basal region and the narrow margins of tibiae concolorous with body, greater portion of tibiae, spur and all tarsal joints except last of a whitish yellow colour. Femora and tibiae of hind legs and last tarsal joint uniform deep dark brown; only basal tarsal joints whitish yellow. Wings hyaline. There is only one conspicuous brownish fascia in the fore-wings arising near the middle of the wing and extending to the wing apex; there is a slight indication of a rudimentary lower fascia just at the base of upper divided by a narrow indistinct hyaline region. Head broader than long. Eyes large, ocelli forming an acute-angled triangle; surface of ocellar region beautifully polygonal. Antennae well developed. In most other features this species resembles the geno-type *C. bifasciata*, H.

Male—smaller than female, a little less than 1 mm. long. The antennae of male (text-fig. *c*) are quite different in structure from those of the female (text-fig. *b*); the funicular joints are long and fringed with long curved hairs. Abdomen short, smaller than thorax. Wings without any brownish fascia as in female.

Described from half a dozen females and from males bred as parasites from the tamarind scale *Aspidiotus tamarindi* G. on the Coimbatore farm. This scale is often a serious pest of tamarind—the foliage and occasionally the fruits being completely covered with colonies of this scale and *Aspidiotus orientalis* N.

Type ♀ in the collections of the Zoological Survey of India (Indian Museum), Calcutta, No. 869/H 3.

The main differences between this Indian species and the previously recorded forms are shown in the following key as a supplement to the table published by Compere (2):—

1. Fore-wings of female with two divergent brownish fasciae.
   - *a*. Colour dark bluish black . . . . *C. bifasciata* Howard.
   - *b*. Colour blue . . . . *C. ceraptocera* Mercet.
   - *c*. Colour dark brownish to metallic green . *C. pia* Girault.
2. Fore-wings of female with two parallel brownish fasciae . . . . *C. unifasciata* Ishi.
3. Fore-wings of female with only one brownish fascia; colour light to dark brown . . . *C. indica*, sp. nov.

The striking difference between these species is to be found in the infuscation of the fore-wing.

All the known species are natives of the Eastern Hemisphere and the majority are from the Oriental region. It is not unlikely that further studies may lead to the discovery of other species in this region.

As a beneficial insect *C. bifasciata* H. was transported from Japan and China into California in 1922 as biological control against citrus-scales of the genus *Chrysomphalus*.

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SEVEN NEW SPECIES OF INDIAN BETHYLIDAE (HYMENOPTERA).

By C. F. W. MUESEBECK, *Bureau of Entomology, United States Department of Agriculture.*

Recently the Bureau of Entomology of the United States Department of Agriculture received for identification a small number of Indian Bethylidae from Dr. T. V. Ramakrishna Ayyar, Government Entomologist at Coimbatore, India. Several undescribed species were included, and since Dr. Ayyar has requested names for use in economic studies, descriptions of the new species have been prepared and are given below. The types are deposited in the United States National Museum, while the paratypes, where available are in the Indian Museum, Calcutta.

The drawings of the two text-figures were prepared by Miss Eleanor A. Carlin of the Bureau of Entomology, United States Department of Agriculture.

Pristobethylus indicus, sp. nov.

(Fig. 1).

Apparently very similar to *serricollis* (Westwood), an African species, but differing in having only the anterior half of the pronotal margin scalloped, and in the more nearly hyaline wings. From *semiserratus* Kieffer, another African species, which the new species resembles in the character of the pronotal margin, it may be distinguished by the head being broadly emarginate behind, by the situation of the lateral ocelli at the posterior margin of the head, by the shorter mandibles, and by the shorter mesoscutum.

Female.—Length 5·5 mm. Head flattened, at least as broad as long, the posterior margin broadly excavated, the posterior lateral angles with three blunt closely-placed teeth; malar space wanting; distance from eye to posterior margin of head more than half the eye length; mandible about as long as eye, the outer margin weakly scalloped; clypeus very small and partly concealed by the bases of antennae; dorsal surface of head very delicately and minutely reticulate, with a few large punctures and long, erect, scattered hairs anteriorly; ventral surface also with long erect hairs; ocellocular line at least one and one half times as long as postocellar line; occiput with abundant long hairs; antennae 13-segmented, a little longer than head; scape large, flattened, with conspicuous spines on its dorsal surface, especially along the margin; pedicel longer than broad, at least as long as second segment of flagellum, a little emarginate above; first segment of flagellum the shortest, not as long as broad; the following subequal, about as long as broad, except the apical segment, which is a little longer than broad.

Thorax strongly depressed, in the region of tegulae about as broad as head, with numerous long erect hairs on the pleura and sternum; pronotum very large, at least as long as broad, its anterior margin, and

the lateral margins half way to the tegulae, conspicuously elevated and scalloped, its dorsal surface minutely reticulate like the head, with

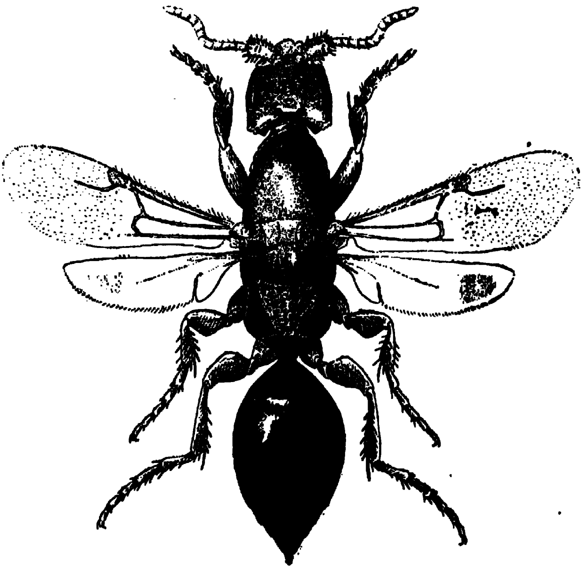

FIG. 1. Female of *Pristobethylus indicus*, sp. nov.

six or eight large scattered punctures on anterior half; mesoscutum not more than one-third as long as pronotum, also minutely reticulate, and with four shallow longitudinal furrows, the median pair posteriorly broadening and deepening into elongate foveae which attain posterior margin of mesoscutum; scutellum gently convex, sculptured like pronotum, and with two widely separated circular foveae at base; dorsal face of propodeum carinately margined on sides and behind, with three longitudinal carinae medially, the median one complete, the other two not quite attaining posterior margin, the area between them crossed by numerous transverse ridges which are intersected by an irregular raised longitudinal line about midway between the median carina and each of the lateral carinae; area between lateral carinae and lateral margins of propodeum very delicately transversely aciculate; posterior face of propodeum abruptly declivous, with a complete median carina, surface very delicately obliquely lineolated; metapleurum closely longitudinally aciculate; anterior coxae at least as large as posterior pair, convex beneath; middle and posterior coxae ventrally flattened; all femora short, with long, erect, scattered hairs, anterior pair longest, middle pair shortest, only about two-thirds as broad as long; middle tibia thickly covered with strong spines on outer side; posterior tibia with a few similar spines toward apex; anterior tarsus rather short,

segments broadening apically and two or three basal segments armed with well developed spines beneath; middle and posterior tarsi slender, with several long spines at the apex of each segment; anterior wing with a very short fringe on outer margin; basal half of wing almost entirely glabrous, apical half closely hairy; median and submedian cells closed; stigma slightly longer than broad; radius strongly curved near base, a little longer than basal vein.

Abdomen shorter than thorax, at its widest point slightly broader than thorax, surface mostly minutely reticulate or lineolate; second tergite larger than any of the following.

Black; mandibles, palpi, clypeus, and antennae ferruginous; tegulae brownish yellow; wings subhyaline; legs brownish red; coxae more or less piceous to blackish; the apical two or three abdominal segments reddish.

Type-locality.—Chaughat, Malabar; India.

Type.—U. S. N. M. No. 50137; *Paratype* No. $\frac{870}{H3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Described from two females collected May 29 and May 31, 1931, respectively, the latter the type.

Perisierola nephantidis, sp. nov.

This species resembles *emigrata* Rohwer but differs in the relatively shorter and broader first discoidal cell, in having the dorsal face of propodeum weakly margined posteriorly toward the sides, in the coarser sculpture of the propodeum and metapleurum, the relatively broader head, and the somewhat paler legs.

Female.—Length about 3 mm. Head not distinctly longer than broad, its dorsal surface finely coriaceous with numerous small but distinct, well-separated punctures; clypeus with a prominent median longitudinal carina which extends caudad to a point about one-third the distance from antennae to median ocellus; eyes broad, narrowed posteriorly, hardly one and one half times as long as broad and shorter than distance between them; ocellocular line at least one and one half times as long as postocellar line; distance from eye to posterior margin of head about half the eye length; antennae about as long as head, scape nearly twice as long as broad, somewhat flattened; remainder of antenna much more slender than scape; pedicel about as long as broad, subequal to basal segments of flagellum; none of flagellar segments except the last distinctly longer than broad.

Thorax slightly narrower than head; pronotum at least one and one half times as long as mesoscutum, finely coriaceous and with some scattered very weak punctures; mesoscutum more than twice as broad as long, with distinct, though delicate, lateral longitudinal grooves, and sculptured like pronotum except that the punctures are as distinct as those of the head; disc of scutellum rather flat, broader at base than long, separated from mesoscutum by a fine grooved line, its surface very delicately reticulate with a few scattered distinct punctures and a small oblique fovea on each side at the base; dorsal face of propodeum uniformly very closely punctate and opaque except for a narrow smooth

and polished strip down the middle; the delicate apical transverse carina broadly obliterated medially; posterior face of propodeum strongly declivous, flat, shallowly raticulate; mesopleurum delicately minutely reticulate; metapleurum very finely, longitudinally wrinkled and opaque; stigma longer than broad, broadening toward apex, much larger than prostigma; basal vein broken distinctly above middle.

Abdomen about as long as thorax and at least as broad, narrowed rather abruptly at base and gradually toward apex, entirely smooth and shining.

Black; mandibles black; antennae entirely brownish yellow; wings hyaline; stigma and prostigma brown; veins yellowish; anterior coxae and femora piceous, the latter paler at apices, middle and posterior coxae more or less piceous, their femora pale brown; all tibiae and tarsi brownish yellow.

Male.—Essentially like the female, except that the mandibles are yellow.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50138, *Paratype* No. $\frac{871}{H3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Host.—The Xyloryctid moth *Nephantis serinopa.*

Described from ten females and one male. The allotype and three paratypes are from the type locality; three paratypes are from Salem; one is from Dharmapuri; one from Tirupatur, and one from Calicut.

Apparently this is the species the life history and habits of which have been discussed by Ramachandra Rao and Cherian[1] under the name *Parasierola* sp.

Perisierola mellipes, sp. nov.

This species also closely resembles *emigrata* Rohwer but may be distinguished readily by its entirely yellow legs and mandibles, elongate eyes, and the presence of a well-developed transverse carina defining posterior margin of dorsal face of propodeum.

Female.—Length 2·2 mm. Head hardly longer than broad; clypeus somewhat compressed and produced anteriorly, its median keel extending back a short distance beyond antennae; surface of head finely coriaceous, with scattered distinct punctures; eyes twice as long as broad, about as long as distance between them and narrowing somewhat anteriorly; posterior margin of head carinate; distance from eyes to posterior margin of head less than half the eye length; antennae as long as head; scape slightly compressed, hardly twice as long as broad and only a little broader than flagellum; pedicel subequal to basal flagellar segments and about as long as broad.

Thorax hardly narrower than head; pronotum and mesonotum delicately coriaceous; mesoscutum on posterior half and scutellum with a few scattered punctures; lateral grooves of mesoscutum distinct; scutellum not broader at base than long; dorsal face of propodeum very finely closely punctate except for a slightly elevated polished strip down the middle; posterior face of propodeum strongly declivous,

[1] *Year Book, Madras Dept. Agric.*, pp. 11-22 (1927).

reticulate; mesopleurum indistinctly reticulate, shining; metapleurum closely very shallowly punctate; stigma longer than broad, broadening toward apex, much larger than prostigma; basal vein broken at about middle; median and submedian cells glabrous toward apex; radius not much more than twice as long as stigma, very slightly curved; posterior femur two and one half times as long as broad.

Abdomen about as long as thorax, narrowing strongly from middle to apex, smooth and shining except for a little faint reticulation at bases of second, third, and fourth tergites.

Black; mandibles, antennae, and all legs entirely, honey yellow; wings hyaline; stigma and prostigma brown.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50139, *Paratype* No. $\frac{872}{H3}$ in the collection of the Zoological Survey of India (Indian Museum), Calcutta.

Two female specimens bred from an unknown host on '*margosa*' March 15, 1932.

Key to the Indo-Australian species of *Perisierola*.

1. Wings distinctly infumated; pterostigma not longer and hardly broader than prostigma; radius sharply angled near apex; propodeum delicately reticulate medially . . . . 1. *angulata* Muesebeck.
   Wings hyaline; pterostigma much longer and broader than prostigma; radius not sharply angled; propodeum polished medially . . 2.
2. Dorsal face of propodeum margined at apex by a distinct complete transverse carina, and elevated keel-like down the middle; eyes twice as long as their greatest breadth; mandibles, and the legs entirely, yellow; basal vein broken at about the middle . . . . 2. *mellipes*, sp. nov.
   Dorsal face of propodeum not margined at apex or the carina only weakly developed toward the sides, and the median longitudinal line not elevated keel-like; eyes definitely less than twice as long as broad; mandibles usually black, sometimes yellow in male; legs usually more or less piceous or blackish . . . 3.
3. Basal vein broken at or above upper third; first discoidal cell twice as long as broad; median polished area of propodeum extending upon the posterior face; metapleurum delicately reticulate and shining; all femora completely blackish; mandibles black in both sexes . . 3. *emigrata* Rohwer.
   Basal vein broken definitely below upper third; first discoidal cell not twice as long as broad; median polished area of propodeum not extending upon posterior face; apices of anterior femora and the middle and posterior femora yellowish brown; mandibles yellow in male . 4. *nephantidis*, sp. nov.

Parasierola quadrifoveata, sp. nov.

(Fig. 2).

Apparently distinguishable from all described species of this genus by the presence of four foveae at base of scutellum and by the unusually small discoidal cell.

Female.—Length 4·5 mm. Head large, as broad as long, dorsal surface strongly coriaceous and opaque, with numerous shallow, well-

separated, umbilicate punctures; clypeus triangularly produced both anteriorly and posteriorly, a little compressed and with a prominent median longitudinal carina which extends caudad nearly to a point opposite the middle of the eyes; eyes much shorter than the distance between them and hardly twice as long as the distance from eyes to posterior margin of head; lateral ocelli removed by about the diameter of one of them from posterior margin of head; postocellar line only slightly longer than diameter of an ocellus and about one-third the oceloocular line; antennae slightly longer than head; scape cylindrical, weakly curved, more than twice as long as thick; pedicel a little less than half as long as scape, much longer than thick and about as long as first segment of flagellum; basal four flagellar segments slightly longer than the others, but all segments distinctly longer than thick.

Thorax much narrower than head; pronotum a little longer than mesoscutum, finely coriaceous and opaque with scattered long erect hairs; mesoscutum twice as broad as long, sculptured like pronotum and with lateral longitudinal grooved lines; the transverse impression

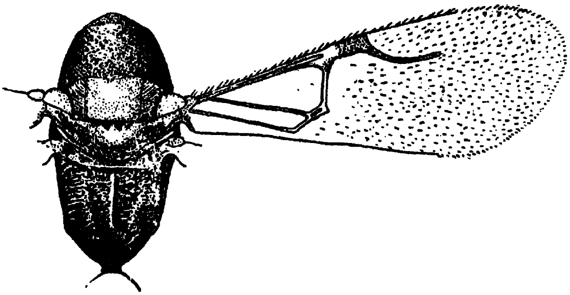

FIG. 2. Thorax of *Parasierola quadrifoveata*, sp. nov.

across base of scutellum divided into four well-marked foveae; disc of scutellum a little more finely coriaceous than mesoscutum; dorsal face of propodeum more than half as long as broad, with a very prominent, complete, median longitudinal carina, and on each side, midway between this carina and the lateral margin, a very weak longitudinal raised line curving slightly inward toward apex and merely representing the outer margin of a shallowly impressed and weakly rugose area; surface between this area and lateral margin finely transversely striate or lineolate; posterior face of propodeum separated from dorsal face by a complete well-developed carina, and very delicately reticulate; stigma much longer than broad, truncate at apex; prostigma very small; radius gently curved, a little more than twice as long as stigma, its apex a little farther from apex of wing than from stigma; basal vein broken at about its lower third; first discoidal cell minute; median and submedian cells very sparsely hairy; posterior metatarsus as long as tarsal segments 2 to 5 combined.

Abdomen slightly longer than thorax, entirely smooth and polished.
Black; mandibles, antennae, and all legs including coxae testaceous; wings hyaline; stigma brown.

Type locality.—Bellary, Madras, India.

Type.—U. S. N. M. No. 50140.

Described from a single specimen reared August 28, 1928, from a cocoon taken on betel leaf.

Pristocera areolata, sp. nov.

In Kieffer's key[1] to the species of *Pristocera* this species runs to *gaullei* Kieffer. It is readily distinguished from that species, however, by its quadridentate mandibles, by having the first flagellar segment nearly four times as long as the pedicel, and by the smoother pronotum and propodeum.

Male.—Length 6 mm. Head slightly longer than broad, its dorsal surface convex, shining, with abundant erect hairs, strongly punctate, the punctures well separated, the interstices polished; eyes bare; level of upper eye margins about on a line with anterior margin of a median ocellus; ocelli separated from each other by only slightly more than the diameter of one of them; lateral ocelli about three times the length of ocellocular line from occipital carina; mandibles very strongly broadened apically, quadridentate, all the teeth large, the outer tooth the largest; apices of teeth in an oblique line; anterior margin of clypeus truncate; antennae about twice as long as head, slender, tapering to the apex; scape cylindrical, rather strongly curved, about three times as long as thick; pedicel a little broader than long; flagellar segments elongate, the first nearly as long as scape, the basal four almost as thick as the scape, the following becoming rapidly more slender.

Thorax at tegulae about as wide as head; pronotum with a low transverse ridge separating the broad smooth apical third from the anterior part which is weakly transversely roughened; mesoscutum nearly as long as pronotum, smooth, with only a few weak punctures, and with four complete distinctly impressed grooves, the middle pair a little farther from each other than from the lateral grooves; a transverse furrow at base of scutellum; scutellum flat, polished, with a few punctures at sides; dorsal face of propodeum as long as broad at apex, weakly carinately margined at sides and apex, and with a complete median longitudinal carina and a more or less irregular, weaker, oblique carina from near each basal lateral angle toward apex of median carina; a few transverse rugae between median and oblique lateral carinae, and four irregular polished areas at base; posterior face of propodeum convex, nearly smooth on the middle, rugose punctate laterally; side of pronotum smooth and polished; mesopleurum punctate, the punctures large, the interstices polished; a narrow distinct longitudinal groove above middle of mesopleurum; metapleurum finely longitudinally aciculate; stigma three times as long as broad, its lower margin gently curved; radius arising from very slightly behind middle of stigma, more than twice as long as stigma, postmarginal vein a little more than

[1] *Das Tierreich*, Lief. 41, p. 454 (1914).

half as long as stigma, first brachial cell very poorly defined; legs slender; tarsal claws with two teeth within.

Abdomen a little shorter than thorax, depressed, smooth and polished, the second and third tergites subequal; the first and second tergites practically glabrous, the third sparsely hairy, the following thickly so.

Black; mandibles reddish, black at base and the teeth blackish; antennae ferruginous; tegulae brownish yellow; wings hyaline; stigma and veins brown, all coxae blackish; femora more or less piceous; tibiae and tarsi yellowish brown.

Type locality.—Coimbatore, India.

Type.—U. S. N. M. No. 50141.

A single specimen collected November 18, 1926.

Epyris politiceps, sp. nov.

In Kieffer's key[1] this species runs best to *pilosipes* Kieffer, but disagrees with the description of that species especially in having the head and pronotum very minutely punctate, the apex of the mandible oblique with the lower margin produced into an acute tooth, and the mesonotum not half as long as pronotum.

Male.—Length 5 mm. Head about as broad as long, nearly round as seen from above, dorsal surface smooth and polished but with numerous minute setiferous punctures, the hairs long, abundant, and suberect; underside of head polished, clypeus very short, its anterior margin a little produced medially; the median keel of clypeus not extending back upon frons; eyes not twice as long as broad, shorter than the distance between them; frons with a fine impressed median line anteriorly; distance from eyes to posterior margin of head more than half the eye length; ocelli large; distance between the median ocellus and one of the lateral ocelli about equal to the diameter of an ocellus; postocellar line less than twice the diameter of an ocellus; ocellocular line twice as long as postocellar line; lateral ocelli removed by one and one half times the diameter of one of them from the carinate posterior margin of the head; antennae twice as long as head; scape hardly thicker than flagellum, about twice as long as thick, pedicel a little broader than long; first segment of flagellum barely longer than pedicel, not as long as broad, second and following flagellar segments more than twice as long as the first, subequal.

Thorax in the region of the tegulae about as broad as head, fully twice as long as broad, pronotum delicately coriaceous, with rather abundant long hairs like the head; mesoscutum not distinctly half as long as pronotum, similarly sculptured, the lateral grooves sharply impressed and extending nearly to the extreme base; disc of scutellum at least as long as mesoscutum, similarly sculptured and provided with a large and deep fovea on each side at base; these foveae separated by less than twice the diameter of one of them; propodeum with dorsal face carinately margined on the sides and behind, the middle third provided with five complete longitudinal carinae which converge slightly caudad, the narrow strips between them traversed by numerous low

[1] *Das Teirreich*, Lief. 41, p. 309, (1914).

transverse rugae; the area between lateral margin of propodeum and the most latera of the five carinae closely aciculate; posterior face of peopodeum closely transversely aciculate and with a complete median longitudinal carina; mesopleurum finely coriaceous; metapleurum longitudinally aciculate; stigma more than twice as long as broad, radius originating from beyond the middle of stigma, not evenly curved; postmarginal vein distinct, nearly one-third as long as stigma; femora stout, the anterior pair slightly larger than posterior pair, the middle pair very small; tersal claws cleft; middle tibia with a few scattered spines on its outer side.

Abdomen shorter than thorax, acute as apex; first and second tergites completely polished and nearly glabrous, the following with abundant suberect hairs.

Black; mandibles, antennae, palpi, and tegulae pale ferruginous; wings subhyaline; stigma and veins brown; legs piceous; tarsi paler; fourth abdominal segment on the sides, and the following entirely, red.

Type locality.—Mysore, India, 1,100 ft. elevation.

Type.—U. S. N. M. No. 50142.

Described from a single male specimen collected April 28, 1918.

Epyris coriaceus sp. nov.

This species runs to *caffrarius* Kieffer in Kieffer's key, but may be distinguished by its coriaceous, opaque, and more uniformly punctate pronotum, by only three of the five longitudinal carinae of propodeum being complete, and by the ferruginous antennae.

Female.—Length 5 mm. Head slightly longer than broad, delicately coriaceous with numerous, but well-separated, distinct punctures; mandibles broadening slightly to the apex, where they are bluntly bidentate, the teeth about equal; eyes less than one and one half times as long as broad and only about a fourth longer than the distance from eyes to posterior margin of head; ocelli small, in an equilateral triangle; postocellar line less than twice the diameter of an ocellus and little more than one-third as long as ocellocular line; scape more than twice as long as broad, somewhat flattened, much broader than flagellum, at least as long as pedicel and the basal two flagellar segments combined; pedicel and first flagellar segment subequal, hardly as long as broad and somewhat shorter and narrower than any of the following segments.

Thorax narrower than head; pronotum sculptured like head except that punctation is more widely spaced medially; mesoscutum not more than half as long as pronotum, with four longitudinal furrows; the lateral pair extending from the posterior margin not quite to the base; the median pair complete, slightly sinnuate, very delicate cephalad but broadening into elongate foveae before posterior margin; disc of scutellum finely coriaceous, with two circular foveae at base separated by more than twice the diameter of one of them; dorsal face of propodeum sharply margined on the sides and behind, transversely aciculate and on the middle third with five longitudinal carinae which are slightly convergent caudad, the median and the two outside carinae complete and much more strongly developed than the other two; posterior face of propodeum transversely aciculate, coarsely so toward

apex and with a complete longitudinal carina; mesopleurum finely coriaceous, with a few scattered punctures; metapleurum closely longitudinally aciculate; stigma about twice as long as broad, emitting the radius from slightly beyond the middle; postmarginal vein not distinct; radius gently curved, about three-fourths complete; second to fourth segments of anterior tarsi cordate, the first to fourth with apical spines; middle tibiae with some distinct spines on the outer side; tarsal claws cleft, the inner tooth small.

Abdomen slightly shorter than the thorax, acuminate; two basal tergites glabrous and entirely polished; the following sparsely hairy; the third, fourth, and fifth each with a few minute punctures toward the base.

Black; mandibles and antennae pale ferruginous; wings a little clouded; tibiae and tarsi mostly dark brown; third abdominal segment on the sides, and the following entirely, red.

Type locality.—Coimbatore, India.

Type. -U. S. N. M. No. 50143.

Described from a single female taken on castor oil plant, May 14, 1932.

MGIPC—M—III-8-2—20-6-34—500.

NOTES ON SOME EARTHWORMS FROM THE INDIAN MUSEUM.

By G. E. Gates, *Judson College, Rangoon, and Biological Institute, Harvard University.*

CONTENTS.

B

INTRODUCTORY NOTE.

As the title indicates this paper is mainly concerned with the results of a study of some of the earthworms belonging to the Indian Museum. A few notes have been included on sundry specimens from other museums.

My heartiest thanks are due to Dr. B. Prashad, Director of the Zoological Survey of India, for the opportunity to examine these collections and for the assistance graciously extended in numerous ways during the course of the investigation.

The figures are from camera lucida sketches by Maung Kyaw Zan to whom the author's thanks are again extended. Except in special cases references to the original specific descriptions are given only for species erected subsequent to the publication of Stephenson's Oligochaeta in the "Fauna of British India" Series.

Family MONILIGASTRIDAE.

Genus **Desmogaster** Rosa.

Desmogaster doriae Rosa.

Material examined.— Karen Hills, east of Toungoo-Burma, October, 1 fully clitellate specimen in excellent state of preservation.

The blood vessels of the reproductive segments of this worm are distended with blood while the vasa defferentia are unusually firm. It has therefore been possible from this worm to clear up the confusion in previous accounts with regard to the vasa defferentia.

The vas emerges from the testis sac and passes ventrally in a straight line on the posterior face of the septum. Before reaching the ventral parietes the vas turns and passes dorsally (either on the posterior face of the septum and covered over by connective tissue or actually within the septum) nearly to the testis sac. Just before reaching the testis sac the vas turns again and passes ventrally in such a way as to form an elongated hairpin loop, the limbs of the loop either in contact or much closer together than either of the limbs is to the entalmost portion of the duct. Before reaching the parietes the vas is twisted several times into short loops, some of the loops are covered over by strong connective tissue. The vas then passes into the parietes and underneath a fairly thick layer of longitudinal muscles and in a straight line to *c* or nearly to *c*. At this point the vas emerges from the body wall and proceeds dorsally along the prostate to the ental end of the latter. No nephridia were found in xi and xii of this worm. A hairpin loop of the vas deferens attached to the posterior face of the septum was probably mistaken previously for a modified nephridium.

Genus **Drawida** Michaelsen.

Drawida affinis Stephenson, *sp. inq.*

Material examined.—One specimen, holotype, in tube labelled, "W 131/1. *Drawida affinis* sp. nov. Rangamati, Chittagong Hill Tracts. 11-vii-15 R. Hodgart."

The type is aclitellate. Definite reproductive apertures are not recognizable. There is a minute vestige of a pore about in line with

b on each side on the posteriormost margin of x; possibly the rudiment of a male pore. There is a pore-like marking about in line with *c* in 7/8 on each side; possibly the rudiment of a spermathecal pore.

The small testis sacs extend from 9/10 only slightly into x. The vas deferens is short with very few loops. The prostate is rather long and spirally coiled; a rather short ental portion is slightly widened. The vas passes into the ectal part of the swollen region.

The spermathecal ampullae are vestigial. The atrium is finger-shaped, erect, on the anterior face of 7/8. The atrium of one side was removed and cleared. The lumen is represented by a narrow slit at the centre, the wall of the atrium being unusually thick.

FIG. 1.—*Drawida affinis.* Spermathecal atrium from holotype. ×*ca.* 46.

There are two or more whitish bodies (enterosegmental organs) on the dorsal surface of the intestine at each side of the dorsal blood vessel, in each of four segments just behind the gizzard region.

In the genus *Drawida* the reproductive apertures and in particular the male pores can be recognized as patent apertures in very small specimens long before the worms have attained their full size. Conversely, the absence of definitely recognizable reproductive apertures on the single specimen of *D. affinis* is evidence that the worm is far from fully grown (or else abnormal). In the absence of any evidence that the specific characteristics of the worm have been developed the species must be regarded as dubious. So far as can be determined the relationships seem to be with *D. hodgarti.* Possibly the holotype of *D. affinis* is a very small and juvenile specimen of *D. hodgarti.*

Drawida decourcyi Stephenson.

Material examined.—One dissected specimen, holotype, labelled "ZEV. 5160/7. *Drawida decourcyi* sp. nov. Upper Rotung, alt. *ca.* 2,000 ft. Capt. M. de Courcy" and two dissected, paratypes, labelled "ZEV. 5381/7. *Drawida decourcyi*. Abor Exped. Renging. 24-xi-11. F. H. Stewart".

One of the paratypes, an anterior fragment, is more nearly mature than the type and from this specimen the subsequent description is mainly derived.

External characteristics.—The prostomium is prolobous.

In intersegmental furrow 7/8 on each side there is a deep invagination with a transversely slit-like aperture. On the anterior wall of this invagination there is a circular area on which the small, primary, spermathecal pore is located.

The secondary male pores (apertures of copulatory chambers ?) are crescentic slits on 10/11, so placed that the concavity of the crescent faces anterolaterally, the median end of the slit about at *b*.

Internal Anatomy.—The gizzards are in xx-xxvii with a rudimentary gizzard in xix.

The testis sacs are (apparently) within posterior outpocketings of septum 9/10 into x, the anterior portion of the pocket is narrowed and contains only the entalmost portion of the vas deferens. The vas is long, twisted into a closely compacted mass of coils that is much larger than the testis sac. Some of the loops of the vas appear to project into ix but are covered over by a delicate transparent membrane that may represent a portion of septum 9/10; coils projecting into x are not (apparently) so covered over. The vas deferens of one side, straightened out but without stretching is 640 mm. long. The prostates are smooth surfaced, firm, rather cone-like bodies. The prostates are not erect but are bent backwards towards the ventral body wall, pushing septa 10/11-12/13 into posteriorly directed pockets within which the prostates are contained. The ental end of the prostate is not pointed but bluntly rounded and at its centre the vas deferens passes into the prostate. To the anterior face of the prostate near the parietes numerous, strong, flattened, muscular bands are firmly attached. The length of the prostate is about 5 mm.; an ental portion about 3 mm. long smooth, an ectal portion about 2 mm. in length roughened by the attachment of the muscular bands. The parietal invagination is continued through the body wall into the ectal portion of the prostate, the lumen within the ectal part of the prostate fairly wide though the wall is by no means thin. On the roof of the copulatory chamber there is a smooth, round, genital papilla, at the centre of which there is a depression. Within this depression and attached at one side is a wrinkled, thin-walled, translucent, penial body. The latter is club-shaped and bears at the centre of the bulbous ventral end a male pore. The stalk portion of the penial body narrows gradually as it passes dorsally into the depression on the genital marking.

The lumen of the prostate is reduced by the projection into it of numerous, long, thick ridges.

The prostates in the holotype are similar to those just described but are smaller.

The ovarian chambers and the ovisacs are not sexual though the ovisacs penetrate into xiv-xvi.

The spermathecal atria are about 8 mm. long and of a rather flattened columnar appearance. An ental, coelomic portion about 5 mm. in length passes into the longitudinal musculature in the anteriormost portion of vii and after a right angled bend passes straight posteriorly within the body wall, opening to the exterior, after passing through the rather thin wall of the parietal invagination, by the pore on the circular area on the anterior wall of the invagination. The lumen of atrium is narrowly slit-like, the wall of the atrium of three distinct layers. The spermathecal duct is about 20 mm. long, glistening throughout and slightly widened ectally. The duct passes through 7/8 and into vii and then into the body wall in vii where it joins the atrium.

Remarks.—The second paratype is quite juvenile. The male pores or apertures of the copulatory chambers are not visible; the *anlage* of the spermathecal pores are possibly represented by the minute, blackish depressions on the posterior margin of vii. The spermathecal ampullae are very rudimentary, the testis sacs are small, the prostates are repre-

sented by a small hemispherical body in the parietes just projecting into the coelom, and the ovarian chamber is shut off only mesially. Even at this stage the coiled mass of the vas deferens is much larger than the testis sacs. The gizzards are in xiv-xx.

Although all of the types are aclitellate and the ovarian chambers and ovisacs are juvenile the prostates and spermathecae and associated structures are sufficiently developed to enable adequate characterization of the species, at least to the extent of distinction from all known forms of the genus *Drawida.*

Drawida hodgarti Stephenson, *sp. inq.*

1917. *Drawida hodgarti* Stephenson, *Rec. Ind. Mus.* XIII, p. 366.

Material examined.—One tube labelled, "W 70/1. *Drawida hodgarti* Stephenson. Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart (Mus. Collr.) Types," containing 3 aclitellate specimens, two of which, paratypes, are unopened.

External characteristics.—On the type-specimen there is on the posteriormost margin of x on each side a whitish, narrow, slightly protuberant, transverse ridge, extending from *a* into *bc*. On the median portion of each ridge is a minute, open, round, male pore, about in line with *b*. The transverse male pore ridge is not quite as well developed on the larger of the two paratypes but is recognizable. The male pores are minute but rather slit-like, diagonally placed but about in line with *b*. The reproductive apertures are not visible on the smaller of the paratypes.

The spermathecal apertures are minute, round pores in 7/8, slightly median to *c* (type). The female pores are minute, transverse slits on the anteriormost margin of xii, about in line with *b* (type).

Immediately anterior to each spermathecal pore, on the type, there is a half-moon-shaped, whitened area, the base or straight margin of the marking on 7/8. There is also a slight, whitish tumescence immediately anterior to the male pore ridge on x on each side.

The definitive genital markings are tiny, transversely oval, greyish areas, just behind *c* on viii and just behind *b* or *ab* on vii.

There are no genital markings on the smaller paratype. On the larger paratype there are four, transverse, greyish-translucent areas on vii, immediately in front of the spermathecal pores and just posterior and slightly lateral to *d*.

Internal anatomy.—(The larger paratype was opened.)

The testis sacs are kidney-shaped and are not constricted by 9/10. The prostates are elongate and coiled, the entalmost portion slightly thicker than the remainder. The vas is rather short, twisted into a small mass of loops on the posterior face of 9/10 under the testis sac; passing into the prostate quite definitely ventral to the ental end.

The ovarian chamber was opened in opening the worm; 10/11 and 11/12 appear to pass independently to the parietes laterally; segment xi is closed off mesially from the oesophagus as in worms with the horseshoe-type of ovarian chamber.

The spermathecal atria are erect, finger-shaped structures in vii. One of these (text-fig. 2) was removed and treated with lactophenol and glacial acetic acid but was not successfully cleared.

FIG. 2.—*Drawida hodgarti.* Spermathecal atrium. ×*ca.* 46.

The gizzards are four in xv-xviii (in the type, according to Stephenson) or three in xv-xvii. There are masses of whitish material (enterosegmental organs) on the dorsal surface of the gut, on either side of the dorsal blood vessel for a few segments posterior to the gizzard region.

Remarks.—*D. hodgarti* is very similar to *D. papillifer* and is distinguished from the latter species only by the small, finger-shaped spermathecal atria in vii. This distinction can be regarded as valid evidence for separation of the species only if the spermathecal atria of *D. hodgarti* have attained their definitive form. The condition of the ovarian chambers, the ovisacs and the spermathecal ampullae shows quite clearly that the types of *D. hodgarti* are juvenile. Quite possibly then the spermathecal atria are also incompletely developed and hence not characterized by definitive form. The difficulty of demonstrating a lumen in the atrium may be regarded as an additional evidence for the immaturity of the atrium.

The types of *D. hodgarti* and *D. papillifer* were all secured along with the holotype of *D. affinis* from one locality, by the same collector and apparently at the same time.

Drawida kempi Stephenson.

1914. *Drawida kempi*, Stephenson, *Rec. Ind. Mus.* VIII, p. 376.
1923. *Drawida kempi*, Stephenson, *Oligochaeta*, *F. B. I. Series*, p. 144.
1914. *?Drawida rotungana*, Stephenson, *Rec. Ind. Mus.* VIII, p. 372.
1923. *?Drawida rotungana*, Stephenson, *Oligochaeta*, *F. B. I. Series*, p. 155.
1914. *?Drawida pellucida*, Stephenson, *Rec. Ind. Mus.* VIII, p. 368.
1923. *?Drawida pellucida* f. *typica* (part), Stephenson, *Oligochaeta*, *F. B. I. Series*, p. 150.

Material examined.—One specimen labelled "ZEV. 5382/7. *Drawida kempi* sp. nov. Egar Stream between Renging and Rotung. 9-i-12. Under stones in water"; two specimens labelled "ZEV. 5154/7. *Drawida rotungana* sp. nov. Abor Exped. Rotung. Alt. 1,300 ft. Under stone. 8-iii-12. S. W. Kemp"; and one specimen labelled "*Drawida pellucida* Bourne (?) (not fully mature). Upper Rotung. 5-i-12. ZEV. 5411/7."

A

The holotype of *D. kempi*.

The male pores are minute apertures, each located on a slight, soft, wrinkled and translucent protuberance which is on 10/11, in *bc*, slightly nearer to *c* than to *b*. The margins of x and xi immediately in front of and just behind these tumescences are slightly swollen but firm. The spermathecal pores are very small, transverse slits in 7/8, about

in *c*. The female pores are very small transverse apertures in 11/12, just lateral to *b*.

The genital markings (?) are a pair of longitudinal, slightly depressed, translucent areas of epidermal thinness. Each of these areas extends anteroposteriorly from just behind 9/10 to just in front of 11/12 and lateromesially from slightly lateral to *c* (as indicated on segments other than x and xi) to *b*. The translucence and depression are most noticeable on the posterior, anterior and lateral margins of each of these areas. Setae *c* and *d* (of x and xi) are displaced laterally, apparently by the development of these markings. In addition to these markings there is a small area, rather faintly indicated, on the right side of ix just lateral and slightly posterior to *b*, that may represent a vestige of a genital marking.

The vas deferens is slender, short, with a few loops, passing into the dorsal surface of the prostate towards the anterior margin. The testis sacs are constricted dorsally by 9/10, the portion of the sac in ix of about the same size as the part in x. "The prostate is a large cuboid milky white mass" (Stephenson, 1914, p. 377) sessile on the parietes. The whitish material is unusually soft, softer than the granular layer so often present on the coelomic face of a prostate in *Drawida*. The whitish material falls apart readily, when probed, into club-shaped bodies. Removal of the whitish material discloses a firm, spheroidal body with the ventral face imbedded in the parietes. This central body is very similar to the prostate of *D. rotungana*.

The spermathecal ampullae are filled with whitish material and are probably fully developed. The ovarian chamber is sexual, distended by ova. The ovisacs appear also to be fully sexual.

Remarks.—The holotype of *D. kempi* is probably fully sexual though aclitellate. The clitellum appears to be a rather evanescent structure in *Drawida* and does not appear until after the internal reproductive organs are fully sexual. The type-specimen may be somewhat abnormal; the thinness and translucence of portions of the ventral epidermis and the vestigial condition of the asymmetrical genital marking (?) do not appear to be quite normal.

The club-shaped bodies into which the whitish material on the prostate fragments are larger, softer and less firmly bound together than the granulations of the coelomic layer on the ordinary *Drawida* prostate.

B.

The types of *D. rotungana*.

The posterior margins of x and the anterior margins of xi are swollen and slightly protuberant in a sort of conical fashion in the region of *bc* on each side. Intersegmental furrow 10/11 is uninterrupted in the region of swelling. The rudiments of the male pores are minute apertures on 10/11, in mid *bc*, each pore about at the centre of the marginal swellings.

The spermathecal pores are minute, in 7/8 just median to *c*, each pore on a slight, transversely ridge-like swelling on the intersegmental furrow. The female pores are transverse slits in 11/12 in *b* or very slightly lateral to *b*.

The genital markings are a single pair of inconspicuous, transversely oval, postsetal areas on ix, the width of the marking about equal to interval *ab*, the depressed centres of the markings in line with *b* or *ab*, the markings about equidistant from the setae of ix and 9/10.

The testis sacs extend into both ix and x, the dorsal margin markedly constricted by 9/10, the portion in ix smaller than the part in x. The vas deferens is short with very few loops. It drops to the ventral body wall in x and after a short loop passes into the anterior face of the prostate close to the parietes. The prostate is a smooth-surfaced, firm, spheroidal body, sessile on the parietes. The coelomic wall of the prostate is a very thin, and transparent but tough membrane. Within this membrane there is very soft, whitish material. At the centre of the whitish material there is a small lumen, crescentic in section. The whitish material is, apparently, continued through the parietes in the form of a small column or plug. If this plug is carefully pulled out from the parietes there is visible at the ventral end of the plug a small bit of epidermis on which the male pore is located.

The spermathecal ampullae of the type are fairly well developed but the ovarian chamber and the ovisacs are not sexual. The spermathecal ampullae are not so well developed in the paratype.

Remarks.—The paratype is smaller, less developed sexually and in a poorer state of preservation than the type. The marginal swellings in the vicinity of the male pores are better developed on the paratype than on the type. On the former the anterior and posterior margins of the swellings (*i.e.*, margins away from the intersegmental furrow) are demarcated by transverse furrows which do not pass, either laterally or mesially, into 10/11.

As the types of *D. rotungana* are not sexual the species cannot be adequately characterized. So far as can be determined the species appears to be close to if not actually conspecific with *D. kempi*. About all that is needed to convert the types of *rotungana* into *kempi* is for the whitish material within the prostate to grow through the tough membranous wall into the coelom as club-shaped bodies. Some such process as this probably takes place in the maturing of *kempi* and a similar development has been previously suggested by Benham in *D. indica*.

Another resemblance possibly of minor importance is that the vestige of a genital marking on the type of *D. kempi* is located approximately in the same position as the genital markings of *D. rotungana*.

C.

The specimen of *D. pellucida*.

The spermathecal apertures are small slits in 7/8, just median to *c*. The male pores are not definitely recognizable. There are no genital markings.

The only indications of the presence of the prostates is the bulging of the floor of x in two places, the longitudinal musculature uninterrupted above the bulges. Presumably rudiments of the prostates within the parietes are responsible for the bulging.

Remarks.—The specimen mentioned above is a very immature juvenile. Organs of taxonomic importance have scarcely begun to develop. Identification, at least at present, is impossible. The worm comes from the same region as *D. kempi* and *D. rotungana* and *D. decourcyi*. The absence of colouration suggests a greater possibility of relationship to *kempi* or *rotungana* than to *decourcyi*.

Drawida limella, sp. nov. ?

Material examined.—"From the edge of a tank at Kinchana," near Amingaon, Kamrup District, Assam. S. L. Hora. 1 clitellate specimen.

Description: External characteristics.—Length, 58 mm. Maximum diameter, 2 mm. There are traces of bluish pigmentation on the dorsum, the pigmentation especially marked in the region of the intersegmental furrows. In the anterior region on each side there is a longitudinal row of tiny but quite evident, blackish spots, each spot in or close to an intersegmental furrow and in line with *c*. The spots are rather pore-like in appearance and doubtless indicate points of especial thinness in the body wall. Similar but less evident spots also in the intersegmental furrows can be recognized in the same region in line *b* on each side.

Setae *ab* and *cd* are closely paired; $aa < bc$.

The clitellum is annular and indicated by a definite whitening of segments ix-xiv.

The spermathecal pores are tiny, transverse slits in 7/8 in mid *bc*.

The male pores were not recognised.

The female pores are in 11/12 about in line *b*.

The male porophores are roughly conical, whitened, conspicuous protuberances belonging apparently to both x and xi as 10/11 ends abruptly against the base (dorsal portion) of the porophore mesially and laterally. The base of the porophore extends from just median to *a* to slightly lateral to *b*. At the ventral end of the porophore is a tiny, nipple-like projection on which the male pore is presumably located.

The genital markings are a pair of transversely oval, whitish areas, each marking in *bc* on the posterior margin of vii. At the centre of each marking is a tiny, round pore which is very slightly lateral to the spermathecal pore.

Internal anatomy.—Gizzards, 3. Last hearts, ix.

The testis sacs are ovoidal, in 9/10 projecting into both ix and x. The vas deferens was traced on one side where it passes ventrally on the anterior face of 9/10 nearly to the ventral parietes and then posteriorly into x where it passes into the centre of the mid-dorsal face of the prostate. The vas is short and almost straight, *i.e.*, without loops. The prostates are represented by circular, sessile patches of granular bodies in the parietes. Removal of the granulations reveals a central body that is thin-walled, transparent, longer than thick with a constant diameter except that in the outermost layers of the parietes and within the male porophore (nipple-portion) the thickness gradually decreases.

Segment xi was opened by the mid-dorsal incision. If an ovarian chamber is present its anterior and posterior walls are considerably

distended by the accumulated masses of ova. The ovisacs are rather thick for 2-3 segments but are continued posteriorly through several additional segments as much narrower, cord-like bodies.

The spermathecal ampullae are ovoidal. The spermathecal duct is rather thick considering the size of the worm, whitish not glistening, looped on the posterior face of 7/8 and passes into the parietes without noticeable trace of an atrial enlargement.

Erect in segment vii and passing into the parietes dorsal to each genital marking is a columnar body with a finely granular, coelomic surface. From a central point on the dorsal end of the column a fine thread rises and then drops over onto the ventral parietes from whence it could be traced no further. This thread is, on one side of the worm, of a faint reddish colour. The granulations can be easily scraped off revealing an elongate, tubular, central body.

Remarks.—The account above is not as complete as is desirable. The anteriormost segments are softened; no setae were visible on these segments.

The ectal end of the male deferent apparatus is probably in an everted condition; it is scarcely probable that the conspicuously protuberant porophores represent the normal condition of the ectal end of the male apparatus in the living worm. The central body of the prostate of one side has been traced through the parietes to the nipple at the end of the male porophore, so that the location of the male pores on the nipple can be regarded as established with a fair degree of certainty. The spermathecal duct has not however been traced through the parietes to the spermathecal pore as is usually done. The location of the spermathecal pore and the absence of an atrial widening of the duct require, in these circumstances, confirmation.

The septa just behind the ovarian segment and the ovisacs are very fragile so that the membranes were ruptured in exploring the postgenital segments. The exact location of the gizzards is not known, possibly they are in xiii-xv.

The glands in vii are of interest; their appearance and gross morphology is almost exactly like that of the prostates of certain species of *Drawida*. The thread which hangs over onto the parietes may possibly be a blood vessel.

D. limella is close to *D. periodiosa* but is distinguished from the latter species by the absence of spermathecal atria and the more lateral (but only slightly) location of the spermathecal pores. Just how significant or real these apparent distinctions may be can only be determined when further material from Amingaon becomes available for study.

Drawida nepalensis Michaelsen.

1907. *Drawida nepalensis*, Michaelsen, *Mitt. Mus. Hamburg*, XXIV, p. 146.
1909. *Drawida nepalensis*, Michaelsen, *Mem. Ind. Mus.* I, p. 147.
1917. *Drawida nepalensis*, Stephenson, *Rec. Ind. Mus.* XIII, p. 372.
1922. *Drawida nepalensis*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 430.
1923. *Drawida nepalensis*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 146.
1909. *Drawida burchardi*, Michaelsen, *Mem. Ind. Mus.* I, p. 149.
1923. *Drawida burchardi*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 134.
1925. *Drawida burchardi*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 50.
1933. *Drawida burchardi*, Gates, *Rec. Ind. Mus.* XXXV, p. 426.

1925. *Drawida papillifer* (part), Stephenson, *Rec. Ind. Mus.* XXVII, p. 51.
1925. *Drawida hodgarti*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 50.

Material examined.—Three juvenile specimens without male porophores and 1 aclitellate specimen with male porophores labelled " ZEV. 2936/7. *Drawida burchardi* Michlsn. Mt. Harriet, S. Andaman. B. B. Osmaton ;" one aclitellate specimen labelled " W 1224/1. *Drawida burchardi* Mich. Mt. Harriet, Andamans. Dr. N. Annandale ;" 9 juvenile specimens without male porophores and 6 aclitellate specimens with more or less rudimentary male porophores labelled " W 1223/1. *Drawida burchardi* Michlsn. Amingaon. Dr. S. L. Hora ;" fragments of two aclitellate specimens labelled " ZEV. 2940/7. *Drawida nepalensis*, Gowchar, Nepal. Hodgart. Type ; " one juvenile specimen without male porophores and one aclitellate specimen with male porophores labelled " W 72/1. *Drawida nepalensis* Michlsn. Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart ;" 7 aclitellate specimens labelled " W 80/1. *Drawida nepalensis* Michlsn. Kierpur, Purneah District, Bihar. C. Paiva ;" two softened, aclitellate specimens with male porophores labelled " W 680/1. *Drawida nepalensis* Michlsn. Compound of Forest Research Inst., Dehra Dun ;" two aclitellate specimens with male porophores labelled " W 1226/1. *Drawida papillifer* Steph., Amingaon, Assam ;" 4 specimens labelled " W 1225/1. *Drawida hodgarti* Amingaon. Dr. S. L. Hora." From the Hamburg Museum : 5 aclitellate specimens labelled " V 7140. *Drawida nepalensis* Michlsn. Hodgart. Nepal ;" 3 aclitellate specimens labelled " V 7170. *Drawida burchardi* Michlsn. B. B. Osmaton. S. Andaman :" and 1 specimen labelled " V 5781. *Drawida burchardi* Mich. W. Burchard. Sumatra."

The holotype of *D. burchardi* is represented at present only by a posterior portion, the anterior end containing all the reproductive structures has been removed and lost. The holotype was aclitellate but the reproductive apertures and spermathecal atria were developed, presumably the worm was fairly near to sexual maturity though the size was small, only 50×1·4 mm. Michaelsen referred worms from the Andamans to his Sumatran species " notwithstanding certain differences". One of these differences that at first appears to rather unimportant is that of size. The worms from the Andamans and India do not have definite male porophores until they are much larger than the Sumatran specimen. Other differences between the Sumatran and Andaman forms will probably, as in the case of body size, be accentuated by completion of sexual maturity. Further, there is no definite evidence in the original description of *D. burchardi* to indicate that the Sumatran worm is conspecific with the forms from other areas that have been referred to *D. burchardi* or *D. nepalensis*.

All specimens of *D. nepalensis* and *D. burchardi* from India, Burma and the Andaman Islands, so far as can be determined in view of the immaturity and preservation, belong to one and the same species. This species, in the absence of definite evidence of identity with the Sumatran form must bear the name *nepalensis*.

The two specimens of *D. papillifer* are quite obviously referable to *D. nepalensis* as at present defined (*vide* Gates, 1933).

One of the specimens of *D. hodgarti*, an anterior fragment, lacks reproductive apertures and is probably not specifically identifiable. The other three specimens are also juvenile but further developed than the fragment.

Greatest length, 128 mm. Diameter, 5 mm. The setae begin on ii and are closely paired, *aa* and *bc* about equal.

The spermathecal pores are minute but open, transversely slit-like apertures, apparently on the posterior margin of vii slightly median

to *c*. The male apertures are minute, open slits in *bc* but much nearer to *b* than to *c*. On one specimen the male pores are quite definitely in 10/11. On the other two specimens each male pore is on a slight, rather indefinite protuberance that involves the anterior margin of xi and the posterior margin of x, intersegmental furrow 10/11 only faintly indicated on the protuberance or lacking, in the latter case the male pore in line with 10/11. The female pores are minute, on the anteriormost margin of xii, in *b*. The nephridiopores of vii and viii are slightly more dorsal to *d* than on the neighbouring segments.

Septa 5/6-8/9 are thickly muscular. The last pair of hearts is in ix. There are two pairs of commissures in viii. There are paired, whitish, enterosegmental organs in each of several segments just behind the gizzard region.

Determination of the segmental locations of the gizzards has been difficult. In a previously opened specimen there are three gizzards in xv, xvi, and xvii and then a break in the gut behind which there is a fourth gizzard much longer than any of the others and apparently in xx. In another specimen the gut just behind xi is rotten and some of the septa are in bad condition but the septa of the gizzard segments appear to be well preserved with the gizzards apparently in xx, xxi, xxii and xxiii. In a third specimen there was, when the worm was first opened, no septum visible at the parietes in the region of intersegmental furrow 18/19. After the specimen had dried slightly it was possible to separate what had appeared at first to be septum 19/20 into two distinct sheets, one of which could be peeled off from the parietes anteriorly to 18/19. In peeling off this septum from the gut the posteriormost gizzard is left in xix with no gizzard in xviii; other gizzards are in xv, xvi, and xvii.

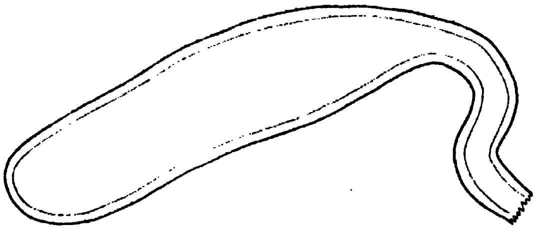

FIG. 3.—*Drawida nepalensis?* Spermathecal atrium of a specimen of *D. hodgarti* Stephenson 1925, *non* 1917. ×*ca*. 26.

The testis sacs are small. The vas deferens is very long, coiled into a mass of loops that is larger than the testis sac. The prostate is elongate, slender, variously twisted; surface, smooth. The vas passes into the extreme ental end of the prostate.

The ovarian chamber was opened by the mid-dorsal incision in each specimen but is probably closed off from the parietes, at least dorsally; mesially the chamber is closed off from the gut. The ovarian chambers are not distended as in sexual animals and the ovisacs are rudimentary. The spermathecal ampullae are also rudimentary.

The atria are long, in fact so long that an atrium is either folded back on itself or else passes dorsally over the gut and dorsal blood vessel into the other side of the body.

These specimens of *D. hodgarti* are quite obviously specifically distinct from the types of *D. hodgarti*. In view of the juvenile condition of the specimens it is possible at present to indicate nothing more than their resemblances to *D. nepalensis*, as remarked above.

Drawida papillifer Stephenson.

1917. *Drawida papillifer*, Stephenson, *Rec. Ind. Mus.* XIII, p. 370.
1923. *Drawida papillifer*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 148.
1922. *Drawida rosea*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 430.
1923. *Drawida rosea*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 155.
1933. *Drawida ancisa*, Gates, *Rec. Ind. Mus.* XXXV, p. 421.

Material examined.—One specimen labelled, "W 83/1. *Drawida papillifer* sp. nov. Rangamati, Chittagong Hill Tracts, Bengal. 11-vii-15. R. Hodgart" and one specimen labelled, "W 681/1. *Drawida rosea* sp. n. Khasi Hills. Sta. 5. S. L. Hora. Under stones and in muddy pools around Dak Bungalow, Cherrapunji, Assam. 28-x-21" and cotypes of *D. ancisa* from Burma.

A.

The holotype of *D. papillifer*. The male apertures are minute, open, diagonally placed, slit-like pores on the posterior margin of x, each pore just lateral to *b*. (The statement as to the position of the male pores in the original account is inaccurate.) The female apertures are transverse slits, on the anteriormost margin of xii, in *b*. The spermathecal pores are minute, open slits in 7/8 slightly median to *c* and are of about the same size as the male pores. The nephridiopores are about in *d* except on viii where they are displaced slightly dorsal to *d*.

Genital markings. (*a*) Two pairs of greyish, translucent, half-moon shaped areas, one pair on vii, one pair on viii, the markings so placed that the straight base of the half-moon is at intersegmental furrow 7/8 with the spermathecal pore near to the median margin of the marking. (*b*) Transversely oval to almost circular, greywish, translucent, small areas located as follows: one presetal marking on xi in *bc* on the right side, near to 10/11; one pair of presetal markings on x in *bc*, the centre of the right marking slightly lateral to the centre of the marking on xi; one pair of postsetal markings on vii, each marking lateral or dorsal to *d*.

The prostate is club-shaped, gradually narrowing towards the parietes, with the surface granular. The vas deferens is short but is twisted into a small mass of loops and passes into the prostate slightly below the ental end. The spermathecal ampulla is fairly large and filled with whitish material. The atria are fairly large, each atrium with a thin-walled, saccular, ental portion and a much narrower, duct portion. The spermathecal duct is slightly widened as it passes into the atrium. The ovisacs are well developed.

B.

The holotype of *D. rosea*. Each male pore is a minute, open aperture on a short, transversely placed ridge that extends on the posterior

margin of x from *a* into *bc*, the male pore very close to *b*. The ridge is especially protuberant about the male pore as a sort of annular lip. The female pores are minute, on the anteriormost margin of xii, in *b*. The spermathecal pores are minute (not conspicuous as previously stated) in 7/8 just median to *c*.

Genital markings. (*a*) Four half-moon shaped areas on vii and viii as on the holotype of *D. papillifer*, the presetal areas on viii smaller than the postsetal areas on vii. (*b*) One pair of presetal, transversely oval, very small areas on xi; the markings nearer to 10/11 than to the setae, extending from slightly median to *b* to slightly lateral to the male pore lines.

The nephridiopores of iii-vii are very slightly dorsal to *d*, while those of viii and ix are still further dorsal to *d*.

The epidermis of a midventral region between the male pores and between the markings of xi is thinned and on this thin region 10/11 is not visible.

There are two pairs of vascular commissures in viii. The entero-segmental organs in xviii-xxi are yellowish and translucent.

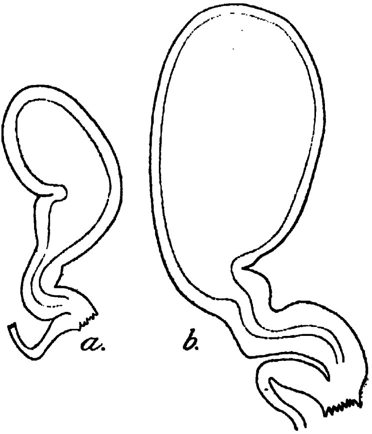

FIG. 4.—*Drawida papillifer*. *a*. Spermathecal atrium from holotype of *D. papillifer*. ×*ca*. 26. *b*. Spermathecal atrium from holotype of *D. rosea*. ×*ca*. 46.

The testis sacs are larger than in the holotype of *D. papillifer*. The vas deferens is short and is twisted into a few, loose coils. The prostates are club-shaped, gradually narrowing towards the parietes, the surface granular, but each prostate is slightly flattened and bent into a u-shape. The vas deferens passes into the prostate slightly below the ental end.

The spermathecal ampullae are large and filled with a whitish material. The atria are large, each with a thin-walled, saccular, ental portion and a much narrower, stalk-like, ectal portion. The spermathecal

duct is slightly thickened as it passes into the atrium. An ovarian chamber, which is closed off mesially from the gut, is present. In the ventral portion of the body 10/11 and 11/12 pass to the parietes independently of each other but dorsally there is only one septal attachment to the parietes, 10/11 doubtless in contact with or fused to 11/12 dorsally. The ovisacs are fairly well developed, each being provided with a posterior appendage or tail which is turned dorsally or ventrally.

Remarks.—The holotypes of *D. papillifer* and *D. rosea* are sexually mature. The differences between the two specimens are unimportant taxonomically, similar variations occur in an extensive series of cotypes of *D. ancisa*. The latter are quite obviously conspecific with the types of *D. papillifer* and *D. rosea*. The erection of *D. ancisa* was necessitated by errors in, and the incompleteness of, the accounts of the earlier species. The types of *D. affinis* and *D. hodgarti* are probably juvenile individuals of *D. papillifer*; the types of all three species are from the same locality; but the spermathecal atria of *D. affinis* and *D. hodgarti* are not sufficiently developed to justify a more definite statement.

Drawida periodiosa, sp. nov.

Material examined.—Agarru, West Godavery District, Madras Presidency, April, K. John, 6 aclitellate and 4 clitellate specimens.

Description: External characteristics.—Greatest length, 57 mm. Maximum diameter, 2 mm. Colour dorsally, deep bluish; of clitellum, reddish.

The setae are closely paired, *ab*=*cd*; behind the clitellar region *aa*<*bc*. All setae of ii or ii and iii may be lacking or *cd* only of ii or ii-iii may be lacking.

The clitellum is annular, the clitellar colouration extending across x-xiii and onto the posterior portion of ix and the anterior portion of xiv.

The slit-shaped spermathecal pores are either in line *b* or very slightly lateral to *b*, in 7/8 or on vii or viii on one of the genital markings in the region of 7/8.

The male pores are probably about in line *b* or very slightly lateral to *b*, the approximate position of the male pore indicated by the lumen of the prostatic duct which is visible in the parietal tissues; the actual male pore and the epidermal tissue immediately around it was not observed.

The female pores are in 11/12, about in line *b*.

The male porophores are whitish, more or less conical protuberances. On some specimens these protuberances appear to belong to both x and xi while on others they appear to belong solely to segment xi. The porophores are in *ab* with the median margins slightly median to *a* and the lateral margins slightly lateral to *b*.

The genital markings of ix and x are presetal, transversely oval areas about in line with but slightly wider than the male porophores and located as follows: one pair on x, 5 specimens; 1 pair on ix, 3; 1 marking on the left side of x, 1; no markings on ix and x, 1 specimen.

On two specimens there are no further genital markings but on each of the other specimens there is an additional pair of smaller markings located as follows: one postsetal marking on vii on each side, 1 specimen; one presetal marking on viii on each side, 2; one marking on each side, extending across 7/8, 1; one marking across 7/8 on the right side, one postsetal marking on vii on the left side, 2; one postsetal marking on vii, on the right side and one presetal marking on viii, on the left side, 2. The markings are about in *ab* (the lateral margin may reach slightly beyond *b*) but are not visible until the margins of the deep groove between segments vii and viii are separated. Each marking is demarcated by a slight but definite circumferential furrow and has at its centre, like each of the posterior markings, a circular pore. The shape of the marking varies from spherical to transversely oval or longitudinally oval.

The nephridiopores are about in line with *d* and are not displaced dorsal to *d* on vii, viii or ix.

Internal anatomy.—Septa 5/6-8/9 are thickened and muscular; succeeding septa thin; 9/10-10/11 dislocated posteriorly, 10/11 attached to the parietes only ventrally.

The gizzards are two, in xiv-xv (2) or xv-xvi (2); or three, in xiii-xv (2) or xiv-xvi (2).

The last pair of hearts is in ix.

The testis sacs are ovoidal or rather flattened bodies, extending apparently into ix and x though not constricted by 9/10. The anterior end of the testis sac is not however in ix but in a space between two lamellae of septum 9/10. These lamellae cannot be separated from each other lateral to the testis sac, but can be traced mesially to the oesophagus and ventrally to the parietes. The ental portion of the vas deferens is between these two lamellae, emerging ventrally into x where it passes posteriorly and into the anterior face of the prostate. The vas deferens is short, looped back and forth in a rather zigzag fashion, especially in x just anterior to the prostate, but not twisted into a mass of coils as in many of the Burmese species. The prostate is a short, cone-like body, erect in x just anterior to the ovarian chamber, with a softish surface of granular appearance. Removal of the granular layer discloses a firm, tubular, relatively quite small, central body just barely protruding through the parietes into the coelom. The vas deferens was broken off while removing the granular layer of the prostate, but as far as can be determined the vas passes into the ental end of the central body.

Segment xi is reduced to a horseshoe-shaped chamber. The ovisacs are fairly large, extending posteriorly into xvi, xvii or xviii. The spermathecal ampulla is spheroidal to ovoidal; the duct which is rather thickish is bent to and fro in a sort of zigzag fashion on the posterior face of 7/8. The spermathecal atrium is a short, stumpy tube, about twice the thickness of the spermathecal duct. Usually the atrium is concealed within the parietes and the tissues of septum 7/8 but in one specimen it protrudes, on each side into vii. The spermathecal duct passes into the posterior face of the atrium.

Dorsal to each genital marking is an erect, thickly tubular gland with a bluntly rounded ental end; the gland projecting conspicuously into the coelom. Each gland is provided with a finely granular investment. The granulations (glands ?) can easily be scraped off revealing an erect, firm, reddish, central body with a narrow lumen which opens to the exterior by the pore at the centre of the genital marking. In three specimens there is visible at the dorsal terminus of each gland in ix a fine thread which rises slightly in the coelom and then falls over onto the parietes in a series of very short rather zigzagged loops. Attempts to trace this thread further, either on or within the parietes failed completely. The glands in vii and (or) viii are usually of the same size, shape and appearance as those in ix but may be a trifle shorter. In one specimen the anteriormost glands are bent, not erect, but project through the parietes into the coelom.

Remarks.—On the whole the worms are in good condition and appear to have been well preserved. However all the specimens have been eroded, possibly due to friction during transportation. The erosion is especially marked on the anteriormost and posteriormost segments and on the projecting male porophores.

The location of the spermathecal pore has been confirmed by tracing the atrium through the parietes. The pore at the ectal end of the atrium is always slit-shaped. This characteristic shape will serve to distinguish the spermathecal pore from a gland pore even when the two pores are on the same genital marking. On one specimen each spermathecal pore is at the centre of a tiny round genital marking that is clearly demarcated by a slight but definite circumferential furrow. This spermathecal pore marking is in contact with a genital marking. On other worms the spermathecal pore is either on the margin of a genital marking or on the intersegmental furrow a slight distance from the genital marking and with no indication of the delimitation of a special area about the pore.

The structures dorsal to the genital markings that project through the parietes into the coelom of segments vii to ix, which have been referred to in the preceding description merely as glands, are of peculiar interest as they are very similar in appearance and structure to prostates and in particular to those of a generalized *Desmogaster* type, as in *D. doriae*. In another Indian species, *D. scandens*, glands in ix, apparently similar to those of *D. periodiosa*, are "of the same size, shape and appearance" (Stephenson, 1921, p. 756) as the prostates in x. In fact, the glands of ix in *D. scandens* have been regarded as prostates and the external apertures as male pores. The interpretation of glands in segment ix as prostates leads to an assumption that the presence of the prostates is evidence for the former presence of an extra pair of testes. Referring to these extra prostates, Stephenson (1921, p. 748) writes, "Michaelsen has previously found a rudimentary second pair in segment ix in *D. willsi* and has argued that the genus originally possessed two fully-developed pairs, of which the anterior has disappeared. This anterior pair, in turn, is the index o a formerly existing second pair of testes, the ancestors of the genus *Drawida* having been holandric while their present day representatives are metandric.

The genus *Desmogaster* is actually holandric and is to be looked on a the most primitive existing member of the family." *D. scandens* wit two pairs of equisized prostates is accordingly regarded "as the mos primitive existing member of the genus at any rate in respect of it male reproductive apparatus" (p. 749).

D. periodiosa does not however fit into the phylogenetic schem quite so nicely as does *D. scandens*. Thus, for instance, is the presenc of "prostates" in segments vii, viii and ix to be accepted as evidenc for the former existence of four or five pairs of testes in the ancestor of *Drawida*? If not, then why are exactly similar "prostates" in vii and viii not as good an evidence for the former presence of testes as "prostates" in ix? Again, the prostates in the coelom of segment ix may belong morphologically to ix (when associated with the genital markings of ix) or to x (when associated with the genital markings of x). In the latter case the glands are actually within the coelom of ix but only because septum 9/10 has been dislocated posteriorly behind its normal level. In such specimens there are two pairs of "prostates" belonging to x. Is the presence of two pairs of prostates belonging to segment x to be accepted as an index of the former presence of two pairs of testes?

While the supposed vestigial prostates are smaller than the true prostates in *D. willsi* and of about the same size in *D. scandens*, they are actually larger and better developed than the true, functional prostates in *D. periodiosa* and *D. limella*. Yet it is these large "prostates" of *D. periodiosa* which are most like a generalized, supposedly primitive and ancestral type of *Desmogaster* prostate.

In these circumstances it appears preferable to regard the structures in vii-ix merely as glands of a rather peculiar type, variable as to number and segmental location in *D. periodiosa*, but possibly more definitely restricted in certain segmental locations in *D. limella*, *D. scandens* and *D. willsi*.

D. periodiosa is close to *D. limella* and *D. scandens*. From the latter *D. periodiosa* is distinguished by the segmental location of the gland pores and by the presence of genital markings on vii and viii as well as by differences in the male porophores.

Drawida pomella, sp. nov.

1925. *Drawida papillifer* (part), Stephenson, *Rec. Ind. Mus.* XXVII, p. 51.

Material examined.—Twenty-one specimens from a tube labelled "W 1226/1. *Drawida papillifer* Steph. Amingaon, Assam".

The male pores are not in mid *bc* but are minute, open, diagonally placed slits on the anterior margin of xi slightly lateral to *b* toward the median margins of the male porophores. The spermathecal apertures are minute (not conspicuous), open slits in 7/8, slightly median to *c* (not in *b*). The female pores are minute, transverse slits on the anteriormost margin of xii, in *b*.

On segment xi there is visible on each side a protuberant area which may be short and transversely ridge-like or more extensive anteroposteriorly and nearly half-moon shaped. The protuberance extends from *b* nearly to *c* and anteroposteriorly from 10/11 nearly to the setae

of xi or only about half way to the setae of xi and is demarcated anteriorly by 10/11 but is otherwise without definite boundaries. On each of these areas there are usually small genital markings, as a rule lateral and posterior to the male pore but rarely just median to the male pore; the number of the markings is variable. Similar genital markings may be present on the posterior margin of x just in front of the male porophore and on the posterior margin of vii in a limited region anterior to each spermathecal pore. These markings are very small, transversely oval to circular, usually quite sharply delineated. Slightly larger markings, closely paired in *aa* may also be present on the posterior margin of x or the anterior margin of xi. Rarely there may be an odd marking or two on viii.

The vas deferens is short, twisted into a few loose loops. The prostate is elongately club-shaped with a short but thick, rounded ental knob and a fairly long narrow stalk. The prostates are variously bent; the surface smooth or very finely granular. The vas passes into the prostate towards the ectal end of the round terminal portion.

The ovarian chamber is closed off mesially from the gut and probably also from the parietes dorsally, as 10/11 and 11/12 pass independently to the parietes only in the ventral portion of the body. The ovisacs are small and vestigial. The spermathecal ampullae are small but within each ampulla is a little whitish material. The atria are elongate and flattened, narrowing gradually towards the parietes. Attempts to clear the atria were not very successful, at least no lumen was seen. The spermathecal duct passes through 7/8 and into the atrium dorsal to the body wall.

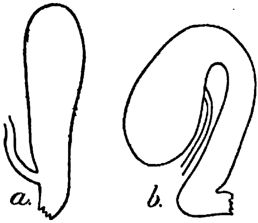

FIG. 5.—*Drawida pomella.* *a.* Spermathecal atrium. × *ca.* 20. *b.* Prostate. × *ca.* 20

The gizzards are 3-4 in xiii-xviii : xiii-xv (1), xiii-xvi (1), xiv-xvi (2). xv-xvii (1), xvi-xviii (1).

There are paired enterosegmental organs on the dorsal face of the intestine in at least 2-4 segments just behind the gizzard region.

Very small, rounded glands protrude through the parietes into the coelom dorsal to the genital markings in one specimen.

Remarks.—The small size of the spermathecal ampullae, the indistinctness and fineness of the granular layer on the prostates, the empty or nearly empty ovarian chambers and the small ovisacs show that the worms are not fully sexual. Nevertheless *D. pomella* can be distinguished from *D. rangamatiana*—the only other Indian species with

male pores on xi—by the genital markings and the associated parietal glands. In these circumstances the erection of a new species seems to be justified even though the specimens are not sexual.

The two specimens of *D. nepalensis* in the tube with *D. pomella* are very readily distinguished from the latter by the larger setae of the anterior segments and the characteristic male porophores.

Drawida rangamatiana Stephenson.

Material examined.—One specimen labelled " W 82/1. *Drawida rangamatiana* sp. nov. Rangamati, Chittagong Hill Tracts, Bengal. 17th July 1915. R. Hodgart."

The spermathecal apertures are minute, just median to *c*; each pore on the posteriormost margin and towards the median border of a genital marking on vii. The female pores are minute, transverse slits in 11/12, just lateral to *b*.

The male pores are minute, diagonally placed slits on slight, transverse protuberances of the anterior margin of xi. Each porophore is delimited posteriorly by a slight furrow that passes mesially and laterally into 10/11. The anterior boundary of the male porophore is a deep groove (much deeper than the furrow at the posterior margin of the porophore), which is regarded as intersegmental furrow 10/11 but slightly dislocated anteriorly by the marginal swelling of xi. The median margin of the porophore does not quite reach to *b* nor does the lateral margin reach to *c*, the male pore quite definitely nearer to *b* than to *c*. A portion of xi just behind each male porophore is also slightly swollen.

Genital markings.—On vii : a pair of postsetal, half-moon shaped areas, the straight bases of the markings about at 7/8 or possibly transgressing that furrow very slightly, the centres of the markings about in *c*. On ix : two patches of special glandularity, each patch extending anteroposteriorly the whole length of the segment in the lateral half of *bc*, the margins of the patches are not clearly demarcated. On x : one pair of postsetal markings, each marking just lateral to the male pore. On xii : a single, transversely oval, presetal area on the right side, the median margin about at *b*.

The last hearts are in ix (not viii as previously stated).

The prostates are elongate and spirally coiled as in *D. longatria* the surface finely granular. The vas deferens is fairly short, looped, back and forth into a fairly regular series which forms a dorso-ventral band on the posterior face of 9/10. The ectal portions of the vasa deferentia were broken across, presumably in the previous dissection. Attached to the ental end of one prostate is a filament that may be a portion of the vas.

The ovarian chamber and the ovisacs are not sexual. The spermathecal ampullae are small and do not appear to be fully developed. The atria are large, conspicuous structures, about 3 mm. in length, reaching to the dorsal blood vessel.

Remarks.—The holotype is not sexual. If the interpretation of the furrows and grooves associated with the male porophores that was

given above be correct, the segmental location of the male pores on xi will distinguish *D. rangamatiana* from other Indian species of *Drawida* (except *D. pomella*) even though the prostates, spermathecal atria and genital markings have not attained their definitive, specific characteristics.

Drawida troglodytes Stephenson.

1924. *Drawida troglodytes*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 129.

Material examined.—One specimen labelled "W 1150/1. *Drawida troglodytes*, sp. nov. Siju Cave, 2,000 feet from entrance. Feb. 1922."

The prostomium is probably prolobous and of the usual type but was damaged in the previous dissection.

The spermathecal pores are very small, transverse slits in 7/8, just median to *c*. The female pores are minute, transverse slits in 11/12, in or slightly lateral to *b*.

The male porophores are transversely oval, extending across 10/11, equally onto x and xi and lateromesially from *b* nearly to *c*. Intersegmental furrow 10/11 ends against the lateral and median margins of the porophores. The anterior and the posterior margins of the porophores are sharply marked off. The male pore is a minute, diagonally placed slit towards the median margin of the porophore and accordingly nearer to *b* than to *c*.

The vas deferens is coiled into a number of loose loops, the mass of loops nearly equal in size to that of the testis sac. One prostate is erect though this may not have been its original condition. The other prostate is bent over posteriorly to pass through the periœsophageal annulus between the ovarian chamber and the oesophagus into xii. The prostates are not spirally coiled.

The ovarian chamber and the ovisacs are sexual but the spermathecal ampullae are rather small, translucent and possibly not fully sexual. There is a pair of unusually large atria in vii. Each atrium is erect but is so long that it passes over to the opposite side of the body above the dorsal blood vessel. The atria are flattened, thin-walled sacs without definite demarcation of a duct but narrowing gradually towards the parietes. An atrium figured here (text fig. 6) had been severed by the

FIG. 6.—*Drawida troglodytes.* Spermathecal atrium. ×*ca.* 11.

previous dissection so that a small ectal portion is still visible in the coelom. The figure does not accordingly show the whole length of the organ. The ental end of this atrium is bent over on itself as a sort of flap; the ental end of the other atrium is invaginated.

Remarks.—According to the original description "there is no trace of an atrium". Possibly the large size is responsible for the atria being overlooked.

The holotype is probably nearly sexual, but if the small size and translucent appearance of the spermathecal ampullae are characteristic of the species the type may be fully sexual.

According to Stephenson the relationships of *D. troglodytes* are with *D. pellucida* but the large spermathecal atria quite definitely negative this suggestion.

Family MEGASCOLECIDAE.

Subfamily MEGASCOLECINAE.

Genus **Plutellus** E. Perr.

Plutellus sp. ?

Material examined.—Gurjung village, Nepaul, K. N. Sharma, 3 aclitellate specimens.

Length, to 50 mm. Diameter, to 4 mm. Male pores in *ab* on xviii. Spermathecal pores paired, in or nearly in line with *c*, in 7/8-8/9. Nephridiopores lateral to *b* (probably).

The intestine begins in xv. The male funnels and the female funnels are readily recognizable. The seminal vesicles are paired in ix and xii; the testes and ovaries large, free in x-xi and xiii. The prostates are tubular, the ducts nearly straight. The ectal tips of the penial setae are bent slightly towards one side and ornamented with rows of teeth. The spermathecae are rudimentary, just barely projecting into the coelom of segments viii-ix.

There is a rudimentary gizzard in v.

Remarks.—In the coelom there are numerous nematodes with strong, paired hooks.

Genus **Tonoscolex** Gates.

Tonoscolex oneilli (Stephenson).

1914. *Megascolides oneilli*, Stephenson, *Rec. Ind. Mus.* VIII, p. 377.
1916. *Megascolides oneilli*, Stephenson, *Rec. Ind. Mus.* XII, p. 314.
1923. *Notoscolex oneilli*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 212.

Material examined.—One specimen labelled "ZEV. 5159/7. *Megascolides oneilli*: Steph. Janakmukh (Abor Exped.) Capt. J. S. O'Neill. Type."

None of the olive green colouration is now visible.

All of the grooves on the male genital shield are not of equal importance. Some represent merely creases in the epidermis. The seminal grooves are L-shaped; the longitudinally placed posterior limb of the L parallel to the midventral line; the transverse limb of the L passing midventrally but ending abruptly before reaching the midventral line. Immediately in front of the median end of each anterior limb of the groove there is a deep depression or invagination with a transverse slit-like aperture. The margin of the aperture of the invagination is tumescent and lobulated, one of the lobulations larger than the others and at the median end of the anterior limb of the seminal groove.

The prostate is folded.

Remarks.—The male pores were not identified. The pores were not visible externally and determination of their position would have involved tracing the prostatic duct through the parietes. The holotype is rather badly preserved and the male genital shield should be preserved in as good condition as possible.

T. oneilli is distinguished from the Burmese and other Indian species of the genus by the invaginations near the anterior ends of the seminal grooves.

Tonoscolex striatus (Stephenson).

1914. *Notoscolex striatus*, Stephenson, *Rec. Ind. Mus.* VIII, p. 380.
1923. *Notoscolex striatus*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 218.
1914. *Notoscolex stewarti*, Stephenson, *Rec. Ind. Mus.* VIII, p. 382.
1923. *Notoscolex stewarti*, Stephenson, *Oligochaeta F. B. I. Series*, p. 216.

Material examined.—Two specimens labelled "ZEV. 5394-5/7. *Notoscolex stewarti* Steph. Rotung, alt. 1,300 feet (Abor Expedt.) Capt. F. H. Stewart. Types"; three immature specimens labelled "ZEV. 5385-6/7. *Notoscolex striatus*, sp. nov. Abor Exped. Rotung, alt. 1,300 feet. 21st December 1912. Under stones. S. W. Kemp:" one dissected, aclitellate specimen labelled "ZEV. 5384/7. *Notoscolex striatus*, sp. nov. Abor Exped. Upper Rotung, alt. ca. 2,000 feet. 4th January 1912. Found in earth when road making"; and 1 dissected specimen labelled "ZEV. 5410/7 *Notoscolex striatus*, sp. nov. Upper Rotung. 5th January 1912."

None of the specimens of *N. striatus* are fully clitellate; one of the specimens in the first tube of *striatus* as well as the specimen in the third tube have slight indications of the development of the clitellar glandularity.

The seminal grooves are usually as figured by Stephenson but on one specimen the grooves are straight, without the laterally directed terminations. The absence of these short terminations may be an individual variation, an abnormality or may represent a juvenile condition. The "tags" may be entirely lacking, rudimentary or well developed. The "tags" when present are developments of the anteriormost margins of xvii and xviii just lateral to the seminal grooves (the intersegmental furrows 16/17-17/18 visible ventrally clear to the seminal grooves). The "tags" are slightly more lateral to the seminal grooves on the types of *stewarti* than on *striatus*.

The types of *stewarti* have markedly protuberant clitella on which the intersegmental furrows are lacking.

The prostates are in xvii-xviii, the portion of the gland in xviii folded so that the lobulation is more apparent than real.

Remarks.—The differences between *stewarti* and *striatus* in size, presence or absence of calciferous glands in ix, size of prostates, the presence or absence of seminal vesicles in xii are of little significance especially in view of the immaturity of the specimens of *striatus*. Intraspecific variation in body size may be considerable within the genus *Tonoscolex*. The very striking similarity, almost identity, of structures on the male genital shield, the seminal grooves and tag-like processes, does furnish very definite evidence for the specific identity of the two forms.

Tonoscolex horai (Stephenson), *sp. inq.*

1922. *Megascolex horai*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 432.
1923. *Megascolex horai*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 247.

Material examined.—One specimen labelled "W 703/1. *Megascolex horai* Steph. Cherrapunji, Assam. Dr. S. L. Hora."

The male pores are minute, on small papillae on xvii. There are no seminal grooves.

The prostates are small, each with two flattened lobes, the length of the prostatic duct which is bent into a single loop slightly greater than the length of each of the lobes. Prostates and ducts are confined to xvii.

The calciferous glands are three pairs in x-xii. The male funnels are paired in ix and x, but there is only a single pair of seminal vesicles in xi.

The spermathecae are in vi and vii. The duct is slightly coelomic but is shorter and stouter than the diverticulum. The latter is longer than the ampulla, slenderly tubular and passes into the median side of the duct.

Remarks.—The holotype of *T. horai* is aclitellate. The species cannot be adequately characterized until mature specimens are available for examination, but even so the type is much more like specimens of *Tonoscolex* than *Megascolex*. Differences from Indian and Burmese species—slightly wider separation midventrally of the spermathecal pores, the absence of the seminal grooves—appear, on the whole to be relatively unimportant, especially in view of the immaturity of the type. Perichaetine setae are present in *T. ferinus* from Burma.

Genus **Pheretima** Kinberg.

Pheretima annandalei Stephenson.

1917. *Pheretima annandalei*, Stephenson, *Rec. Ind. Mus.* XIII, p. 386.

Material examined.—The holotype in a tube labelled "W 8/1. *Pheretima annandalei* Stephenson, Casuarina woods at Singgora, Talé Sap, Siam. Dr N. Annandale."

The setal numbers are: vi/28, vii/30, viii/40, xvii/15, xviii/12, xix/17.

The spermathecal pores (secondary) are fairly large, transverse slits in 5/6-8/9.

The apertures of the copulatory chambers are transversely slit-like with tumescent and finely lobulated margins.

The genital markings are very small, rounded tubercles located in the midventral region. On viii, a presetal row of three markings near the anterior margin and a postsetal row of three markings. In addition a single presetal marking between the anterior row and the setae. On xviii, one presetal marking and a postsetal row of 3 markings. On xix, two presetal rows of three markings each and two postsetal tubercles, one near the setae and one just in front of 19/20. Single markings on viii, xviii and xix are in line with one of the markings in the rows.

The intestinal caeca are simple.

The prostatic ducts are bound by connective tissue to the dorsal faces of the very conspicuous copulatory chambers. Within the copulatory chamber is an elongately tubular penis, slightly more than 2 mm. in length. The penis is slightly widened in the dorsalmost portion of the chamber.

The seminal vesicles are very large.

The spermathecae (text fig. 7) are similar to those of *P. gemella.*

FIG. 7.—*Pheretima annandalei.* Spermatheca. $\times$*ca.* 11.

Remarks.—The holotype is probably incomplete posteriorly.

P. annandalei can be distinguished, for the present, from *P. floweri* by the presence of the genital markings and from *P. gemella* by the absence of the pseudocopulatory chambers in xix or xix and xx.

Pheretima bipora (Beddard).

1900. *Amyntas biporus*, Beddard, *Proc. Zool. Soc. London*, p. 908.
1932. *Pheretima bipora*, Stephenson, *Ann. Mag. Nat. Hist.* (Ser. 10) IX, p. 213.

Material examined.—From the British Museum; three specimens in a tube labelled "*Amyntas biporus.* 1904. 10th May 1915-16. Malay Peninsula. Coll. Beddard."

The genital markings are paired and postsetal on vii. The two markings nearer the midventral line are transversely oval and close to the setae. The smaller markings are circular or nearly circular, close to 7/8, one marking just median to each spermathecal pore in 7/8. The larger markings are probably about 7-8 intersetal intervals median to the spermathecal pores.

Remarks.—Stephenson looked at these specimens, noting that the jar contained "three hard, black and shrunken specimens, in which even the external characters are not distinguishable." The worms were soaked for 24 hours in water and after this treatment the external genital markings could be recognized. None of the specimens had been previously dissected. The soaking in water did not appear to be sufficient to enable much of the internal anatomy to be worked out, but four brief notes were jotted down which are transcribed herewith. The protuberant body in the pseudocopulatory chamber in xix is more like the penis in the copulatory chamber of xviii than in *P. gemella.* The spermathecal diverticulum appears to pass into the duct nearer to the parietes than in *P. gemella.* The last pair of hearts is probably in xiii. The testis sacs of x and xi are probably U-shaped, the seminal vesicles of xi within the sac of that segment (?).

Remarks.—*P. bipora* can be distinguished from *P. gemella*, for the present, by the paired, transversely oval genital markings and the limitation of the genital markings to a postsetal location on vii.

Pheretima dunckeri Michaelsen.

1902. *Pheretima dunckeri*, Michaelsen, *Mitt. Mus. Hamburg*, XIX, p. 9.

Material examined.—From the Hamburg Museum, four clitellate and undissected specimens and some fragments in a tube labelled, " V 5876. *Pheretima Dunckeri* Michlsn. Duncker. Malayische Halbinsel."

External characteristics.—The first dorsal pore is 11/12 (3).

The spermathecal apertures (secondary) are transversely slit-like openings in 6/7-7/8 into deep invaginations. On the anterior wall of the invagination and sometimes visible from the exterior if the aperture gapes open or is held open there is a genital marking on which there is a minute pore. This pore may possibly be the minute, primary spermathecal pore.

The "grosse männliche Poren" (Michaelsen, 1902, p. 10) are the apertures of the copulatory chambers. The smaller male pores are located on penial bodies in the copulatory chambers. These bodies may be visible from the exterior when the aperture of the chamber is relaxed. The penial bodies are softened and wrinkled and probably somewhat macerated.

On vii there are about 19 spermathecal setae. Presumably the midventral setae on xviii have dropped out.

Internal Anatomy.—The intestinal caeca are simple. The single heart of ix is on the left side. The last pair of hearts is in xiii.

The testis sacs of x and xi are unpaired and U-shaped. The hearts of x are within the limbs of the sac which are in contact dorsally above the gut but apparently not fused mid-dorsally. The seminal vesicles and hearts of xi are included within the limbs of the sac of xi; the limbs of the sac not in contact above the gut and but loosely attached by connective tissue to the gut. The prostatic duct is rather slender, slightly sinuous and passes into the lateral face of the copulatory chamber close to the parietes. The copulatory chambers are large. The prostates extend through xix-xxiv.

The dorsal portion of a spermathecal invagination projects in a rounded fashion quite noticeably into the coelom. The diverticulum which passes into the posterior face of the duct is twisted into a closely compacted mass of loops from which projects slightly the ovoidal ental terminus.

Remarks.—Only one other quadrithecal species of *Pheretima* with spermathecal pores in 6/7-7/8 is known at present from the Asiatic mainland, *P. immerita* from Burma. The latter is distinguished from *P. dunckeri* by the presence of septa 8/9-9/10.

Pheretima floweri (Benham).

1897. *Perichaeta floweri*, Benham, *Journ. Linn. Soc. London*, XXVI, p. 217.
1900. *Pheretima floweri*, Michaelsen, *Das Tierreich*, X, p. 267.

Material examined.—Three softened specimens in a tube labelled "*Perichaeta floweri.* 96. 9. 30. 9-11. Bukit Timah, Singapore. S. S. Flower."

The setal numbers are : vi/11, vii/14, viii/13, xviii/8. Setae are present ventrally on xvi.

The clitellar colouration does not extend either to 13/14 or to 16/17.

The female pore is single.

The apertures of the copulatory chambers are transversely slit-like with the margins in apposition.

The spermathecal apertures are tiny, transverse slits ; four pairs, in 5/6-8/9.

There are no genital markings. The "flat, rounded papillae" mentioned by Benham are doubtless the copulatory chambers which are visible through the transparent epidermis as white, circular patches.

According to Benham, "one of the 'penial ducts' is partially protruded" from the aperture of the copulatory chamber. The penes are not actually visible externally but a flattened tag-like process protrudes slightly from one of the copulatory chamber apertures. Doubtless it is this tag-like process which was referred to as a "penial duct."

Septum 8/9 is possibly present (?).

The intestinal caeca are simple, probably extending from xxvii into xxi. The last pair of hearts is in xiii (2).

Each seminal vesicle is provided with a finger-like to conical, primary ampulla (2). There are paired pseudovesicles in xiii and xiv (2). The prostates extend through xvii-xviii or xvi-xviii. The prostatic ducts are short but stoutish and nearly straight. The copulatory chambers are fairly large. Within the copulatory chamber is an elongately tubular penis, the dorsalmost portion slightly thicker than the ventral terminus.

The spermathecal diverticulum comprises a slenderly tubular stalk and an ovoidal, definitely demarcated, seminal chamber.

Remarks.—One of the specimens is very badly softened and was completely disregarded. The account above is based mainly, and so far as the external characteristics are concerned entirely, on an undissected specimen. Some of the internal structures in both specimens are now rather shapeless.

Pheretima hawayana (Rosa) 1891.

"Banks of stream north of Mowkhar," Shillong, Dec. 4, 1930. H. S. Rao, 2 clitellate specimens.

Material examined.—Kali Jhora, Kafibari and Singla Tea Gardens, Kurseong, 4,000 feet, Sta. 20, March 6, 1926, M. Sharif, 6 clitellate specimens.

Pheretima houlleti (E. Perr.) 1872.

1916. *Pheretima trivandrana*, Stephenson, *Rec. Ind. Mus.* XII, p. 335.
1923. *Pheretima trivandrana*, Stephenson, *Oligochaeta*, *F. B. I. Series*, p. 314.
1898. ? *Perichaeta travancorensis*, Fedarb, *Journ. Bombay Nat. Hist. Soc.* XI, p. 435.

Material examined.—One specimen labelled "ZEV. 7233/1. *Pheretima trivandrana* Stephenson. Trivandrum Museum, Trivandrum, Travancore. Type." From the British Museum : two dissected specimens labelled "*Pheretima crescentica ?* 1904. 10. S. 18-26. Dehra Dun. Coll. Beddard" and one specimen labelled "*Megascolex (Pheretima) houlleti* E. Perr. 1924. 6. 21. 6. Salem and Bangalore."

The holotype of *P. trivandrana* is aclitellate but is quite obviously referable to *P. houlleti* ; the spermathecae, copulatory chambers and

penial bodies are quite characteristic. One spermatheca has an extra diverticulum.

The specimens from the British Museum are quite clearly referable to *P. houlleti.*

Fedarb's *P. travancorensis* is something of a puzzle. The type is, apparently, no longer in existence. The original account which has never been emended is inadequate. Except for the spermathecae the worm could quite easily be placed in *P. houlleti.* Possibly Fedarb mistook the stalked glands associated with the spermathecae for the spermathecal diverticula.

Pheretima mekongiana (Cogn.).

1922. *Megascolex (Promegascolex) mekongianus*, Cognetti di Martiis, *Boll. Mus. Zool. Torino*, XXXVII, No. 744, p. 3.

Material examined.—From the British Museum: the holotype in a tube with the following label "*Megascolex (Promegascolex) mekongianus.* 1921. 7. 30. 4. (Type). R. Mekong (Ban Leum) Annam. Pres. Dr. Malcolm Smith."

The single, female pore is on xiii.

The male pores are short, transverse slits, on xvii; each male pore towards the lateral margin of a fairly large disc that is apparently retractile into the parietes. Just lateral to each male-pore disc there is a rather crescentic but deeply bowed groove, the concave side of the groove facing midventrally.

The spermathecal pores are transverse slits; four pairs, in 4/5-7/8.

The intestinal caeca are simple.

In the pharyngeal region there are acinous masses of "blood glands."

Remarks.—The holotype is immature, the clitellar glandularity only slightly indicated. The internal organs of the anterior end are rather messed about as a result of the previous dissection.

The worm is obviously a *Pheretima* as indicated by the testis sacs, the intestinal caeca and the blood glands, but whether the holotype is to be regarded as an abnormal specimen or the species as characterized by an anterior homeosis is not obvious. The male and female pores, the origin of the intestine and the intestinal caeca, and the gizzard are all one segment anterior to the usual locations in the genus. It might almost be expected, in these circumstances that the testis sacs and the seminal vesicles would also be one segment anterior to their usual location. According to Cognetti di Martiis, however, the seminal vesicles are in xi and xii while the testis sacs are in x and xi, *i.e.*, in the segments in which they would normally be found. If these locations are correct the last pair of testes are just one segment anterior to the ovaries while the last pair of seminal vesicles are actually in the ovarian segment. These are characteristics so very unusual that they might almost be regarded as evidences of abnormality.

Pheretima mirabilis (Bourne).

1887. *Perichaeta mirabilis*, Bourne, *Proc. Zool. Soc. London*, 1886, p. 668.

1900. *Pheretima mirabilis*, Michaelsen, *Das Tierreich*, X, p. 284.

1891. *Perichaeta heterochaeta*, Michaelsen, *Abh. Ver. Hamburg*, XI, part 2, p. 6,

1923. ***Pheretima heterochaeta*** (part), Stephenson, *Oligochaeta in F. B. I. Ser.*, p. 302.

With reference to *P. heterochaeta* Stephenson 1923, "The extra-Indian distribution of *P. heterochaeta* on p. 304 of my F. B. I. volume is all wrong, since it includes the localities of *P. indica* as given in Michaelsen's 'Tierreich' volume—I was under the impression, when I compiled the list, that *P. indica* was a synonym of *P. heterochaeta*" (from a letter of J. Stephenson, dated Aug. 12th 1930).

1926-32. ***Pheretima heterochaeta*** Gates, *Rec. Ind. Mus.* XXVIII, p. 156 ; XXXII p. 310 ; XXXIII, p. 387 and p. 487 ; XXXIV, p. 524 ; XXXV, p. 529.

1900. ***Pheretima indica*** (part) Michaelsen, *Das Tierreich*, X, p. 275.

Material examined.—"From among potato plantation fields and cowdung manure on the gorge below Dumpep Dak Bungalow," Cherrapunji, Nov. 19, 1926, S. L. Hora, 109 clitellate and 7 aclitellate specimens.

"Banks of the stream north of Mokhar," Shillong, Dec. 4, 1930, H. S. Rao, 12 clitellate specimens.

Myntaung Valley, Nartiang, Jaintia Hills, Assam, Nov. 28-29, 1930, H. S. Rao, 2 clitellate specimens.

Bababudan Hills, Mysore State, Dec. 1928, Dr. H. S. Rao, 2 clitellate specimens.

"Ravines and tea gardens between Clarendon Hotel and Forest Office," Kurseong, Darjiling District, Sta. 22, March 8, 1926, M. Sharif, 16 clitellate specimens.

Kalimpong, May 23, 1930, 53 clitellate specimens.

Tista Bridge, June 2, 1930, 7 clitellate specimens.

"Round about the forest office near Victoria School," Kurseong, Darjiling District, Sta. 21, March 7, 1926, M. Sharif, 7 aclitellate specimens.

"Under stones along sides of Evelyn Ride and the Golf Course," Shillong, Dec. 7-8, 1930, H. S. Rao, 5 clitellate specimens.

Happy Valley, near Shillong, Nov. 16, 1930, H. S. Rao, 5 clitellate specimens.

Eagles Crag near the Railway Station, Kurseong, Darjiling Dist., Sta. 24, March 10, 1926, M. Sharif, 3 clitellate specimens.

Shillong-Cherrapunji Road, near Shillong, Dec. 6, 1930, H. S. Rao, 3 clitellate specimens.

Kali Jhora, Kafibari and Singla Tea Gardens, Kurseong, 4,000 feet, Sta. 20, March 6, 1926, M. Sharif, 3 clitellate specimens.

Postclitellar genital markings are lacking except for one or two, tiny markings located either on the male pore area or in contact with the male pore area and within the concentric furrows surrounding the male pore area. Preclitellar genital markings are usually present and may be either presetal or postsetal. The presetal markings are 2-3 intersetal intervals median to the spermathecal pores, while the postsetal markings are usually located just in front of the spermathecal pores. The postsetal markings are smaller than the presetal markings. On a series of 44 individuals selected at random the markings are located as shown below.

Genital markings.	Specimens.
Presetal, on vi-ix	1
Presetal, on vii-viii	7
Presetal, on vii-ix	15
Presetal, on viii	3
Presetal, on viii-ix	2
Presetal, on vii-ix ; postsetal, on vi-viii	4
Presetal, on vii-viii ; postsetal, on vi-viii	7
Presetal, on viii ; postsetal, on vii-viii	1
Presetal, on vii-viii ; postsetal, on vii-viii	1
Lacking	3

There are fairly large, paired lymph glands in the postclitellar segments and blood glands in v and vi. There are masses of nephridia in v and vi.

The single heart of ix is on the left side in 13 specimens, on the right side in 3 specimens. Hearts of x are lacking in 15 specimens. In one worm a heart belonging to segment x is present on the side opposite to that of the commissure of ix. This aberrant vessel cannot be confused with a posteriorly dislocated heart of ix as it arises from the supra-oesophageal trunk and passes into the testis sac of x ventrally.

The intestine begins with 15/16 (16). The intestinal caeca are simple and in each of the worms are without marginal constrictions of any sort.

One worm has a pair of prostates, 4 worms have each a single, rather small prostate, 11 worms have no prostates. Prostatic ducts are present though the glands are absent, the duct always c or u-shaped.

The testis sac of xi is unpaired and median in each specimen (16). In one worm no funnel is present in the sac of xi on the left side, but on the posterior face of 11/12 projecting freely into xii is a funnel, presumably the missing funnel of xi.

The testicular material of segment x may be in two distinct ovoidal masses on the anterior face of septum 10/11, the masses rather diagonal in position—the dorsal ends more median than the ventral, or the ovoidal masses may not be discrete but connected transversely by testicular material in shape varying from slenderly cord-like to thickly band-like, or the masses themselves may appear to be directly in contact by their dorsal ends, with little if any appearance of a transverse bridge or band in between (fused). The connection or fusion of the testicular masses produces an appearance which has been referred to in phrases such as " testis sacs of x paired but with transverse connection ". The variation in the appearance can be interpreted however as the result of varying degrees of contraction of a single, unpaired, testis sac ; the greater the contraction the more the resemblance to a paired condition. Weaker contraction on the other hand results in less indication of pairedness. In these circumstances it seems to be preferable to refer to the testis sac as unpaired rather than paired, especially when the latter term must be qualified by some statement as to transverse connection. Furthermore in each of the specimens with two, discrete, ovoidal masses of testicular material it is possible to demonstrate a connection (passage) between the two lateral portions of the sac in which the testicular material has been concentrated, even though there is no testicular material in the passage. In these particular worms it would appear that the semi-fluid contents of the single sac have been thrown into the lateral portions of the sac by strong contraction and there coagulated into ovoidal masses by the process of preservation.

The demonstration in each of these specimens of *P. heterochaeta* that the two discrete masses of testicular material are really in lateral portions of an unpaired testis sac has been possible owing to the fact that in each of the worms the membranes concerned, though thin, are strong enough to permit manipulation with the dissecting instruments. Often one must deal with worms in which the membranes are so fragile or

so poorly preserved that they rupture when manipulated before the condition of the sac can be determined.

Septum 10/11 is held posteriorly in such a way that the testis sac on its anterior face appears, in a mid-dorsal dissection, to be on the ventral parietes with a deeply incised or bilobed anterior margin. But if the tissue which holds 10/11 backwards be cut and the septum held erect, the location of the sac on the anterior face of the septum with the ventral lobes of the sac not quite reaching the ventral parietes becomes immediately obvious.

The length of the spermathecal duct absolutely and relative to the length of the ampulla varies, but is. almost always if not always. fairly slender. The length of the diverticular stalk relative to the length of the spermathecal duct varies but in each of the specimens the stalk is longer than the seminal chamber. The latter is clearly and sharply delimited from the stalk, and is not as in *P. hawayana* merely a rather indefinite and rather slight, short widening of the ental end of the stalk.

The South Indian specimens collected in Mysore not far from the type locality of *P. mirabilis* are characterized by the presence of four pairs of tiny postsetal genital markings on v-viii and two pairs of larger presetal markings on vii-viii. Each postsetal marking is close to the posterior margin of the segment, just in front of or a tiny trifle median to the spermathecal pore. The number, segmental location, and intrasegmental position of these markings is exactly as in Bourne's *P. mirabilis*. There can be very little if any doubt that these Mysore worms actually belong to Bourne's species. *P. mirabilis* as it can now be defined is not distinguished from *P. heterochaeta* Mich. by any characters of specific or subspecific importance. Michaelsen's name accordingly falls into the synonymy of *P. mirabilis*.

An examination of a number of specimens from Northern India which had been identified as *P. heterochaeta* disclosed several with four pairs of postsetal markings. Not all of these markings are however easily recognizable. In most of the worms the markings on v-vi or vii are not visible at all until after the cuticle is peeled off. On other worms no postsetal markings can be found on v-vi or vii even after removal of the cuticle, yet at the approximate site of each marking there is a tiny pit or pore. On opening these worms stalked glands are visible the ducts of which pass through the parietes to the pits or pores just mentioned.

On the other hand, in a number of worms on which postsetal markings are readily visible without removal of the cuticle the stalked glands are smaller and much more difficult to find or lacking (?). The glands (also glands of presetal markings) may be entirely within the longitudinal musculature or on the parietes but covered over by connective tissue or slightly protuberant into the coelom. The glands of the postsetal markings are quite anterior to the markings, the rather long stalk or duct passing posteriorly within the parietes. In worms with four pairs of postsetal genital markings the number of presetal markings varies from 0-3 pairs.

In the table on page 261 only those markings which can be definitely identified without removal of the cuticle are noted; no reference to pits or pores that may be recognizable is included.

Pheretima robusta (E. Perr.).

1872. *Perichaeta robusta*, E. Perrier, *Nouv. Arch. Mus. Paris*, VIII, p. 112.
1900. *Pheretima robusta*, Michaelsen, *Das Tierreich*, X, p. 299.
1925. ?*Pheretima himalayana*, Stephenson, *Proc. Zool. Soc., London*, p. 893.

Material examined.—From the British Museum: one fairly well preserved, dissected but aclitellate specimen in a tube labelled, "*Pheretima mandhorensis*. 1904. 10. 5. 1401. West Indies. Coll. Beddard" and the holotype of *P. himalayana* in a tube labelled, "*Pheretima himalayana* Stephenson. Type. 1924. 10. 21. 27. Darjiling, 7,000 feet. Mount Everest Expedition 1924."

The male pores, on the specimen of *P. mandhoresis*, are minute, each pore on a small, transversely oval tubercule. Just median to each male pore tubercle there is a similar, presetal tubercle. Near the midventral line, close to the setae and also on xviii there is a pair of presetal, genital markings. There are four pairs of presetal, preclitellar genital markings, on viii and ix; one marking immediately posterior to each spermathecal pore and another marking slightly median and slightly posterior to the spermathecal pore marking. Setae: viii/*ca.* 22, xviii/*ca.* 23.

The intestinal caeca are simple; the ventral margins lobulated. The last pair of hearts is in xiii. Each seminal vesicles is provided with a distinct primary ampulla. In xiii there is a pair of pseudovesicles.

The setae, on the holotype of *P. himalayana* are: viii/*ca.* 15, xviii/16. Each minute male pore is on a small, transversely oval tubercle. A single, presetal tubercle is visible on ix, the tubercle just median to the probable location of the spermathecal pore.

The intestinal caeca are simple.

Remarks.—The holotype of *P. himalayana* is probably not fully mature, the clitellar glandularity is only slightly indicated and the setae are visible on all three of the clitellar segments.

The specimen is very similar to some more or less abnormal specimens of *P. robusta* from Szechuan and also to *P. ornata* from the northern portion of the Shan Plateau in Burma.

Pheretima virgo (Beddard), *sp. inq.*

1900. *Amyntas virgo*. Beddard, *Proc. Zool. Soc. London*, p. 895.
1932. *Pheretima virgo*, Stephenson, *Ann. Mag. Nat. Hist.* (Ser. 10) IX, p. 236.

Material examined.—From the British Museum; two specimens in a tube labelled, "*Amyntas virgo* (types) 1924. 3. 1. 211. 13. Malay Peninsula. Cambridge (E.)" and one specimen in a tube labelled, "*Amyntas virgo*. 1904, 10. 5. 197. Malay Peninsula. Coll. Beddard."

The spermathecal setae on vii and viii are about 24 or 25. The spermathecal apertures are transversely slit-like. The apertures of the copulatory chambers are also transversely slit-like.

Each seminal vesicle is provided with a primary ampulla which is sunk into the dorsal margin of the ventral lamina. In xiii there are paired pseudovesicles. In each copulatory chamber that was opened there are three genital markings, one of which is much larger than the others. Owing to the softened condition of the structures the male pores were not definitely identified. The spermathecal diverticulum passes into the lateral side of the duct within the parietes.

In the nerve cord of one of the specimens there are cysts. On the coelomic face of the parietes of another specimen there are numerous, tiny, whitish cysts.

Remarks.—All specimens hitherto referred to this species, *P. virgo*, are doubtless abnormal, at least so far as the spermathecae are concerned. The spermathecal abnormalities are quite possibly the result of a heavy parasitic infestation. The parasites may also have influenced other characteristics of taxonomic importance in these specimens. As the "normal" characteristics of the species to which the worms belong cannot be determined, the status of the species remains dubious, though the relationships appear to be with *P. mamillana* from Burma.

Genus **Perionyx** E. Perr.

Perionyx macintoshii Beddard.

1892. ***Perionyx macintoshii***, Beddard, *Proc. Zool. Soc., London*, p. 687.
1895. ***Perionyx macintoshii***, Beddard, *Monog.* p. 438.
1900. ***Perionyx m'intoshi***, Michaelsen, *Das Tierreich*, X, p. 208.
1917. ***Perionyx m'intoshi***, Stephenson, *Rec. Ind. Mus.* XIII, p. 383.
1931. ***Perionyx m'intoshi***, Stephenson, *Rec. Ind. Mus.* XXXIII, p. 184.
1883. ?***Perionyx m'intoshii***, Beddard, *Ann. Mag. Nat. Hist.* (Ser. 5) XII, p. 217.
1924. ***Perionyx m'intoshi***, Stephenson, *Rec. Ind. Mus.* XXVI, p. 341.
1916. ***Lampito dubius***, Stephenson, *Rec. Ind. Mus.* XII, p. 315.
1923. ***Megascolex dubius***, Stephenson, *Oligochaeta, F. B. I. Series*, p. 210.

Material examined.—Two specimens of *Perionyx m'intoshii* in tubes with following labels: "W 87/1. Nepal Valley, E. Himalayas. Lt.-Col. J. Manners-Smith. Alt. 4,500-6,500 feet" and "W 1129/1. Cantonment Hill, Cherrapunji, Assam, 4,300 feet. Dr. S. L. Hora" and the holotype of *Megascolex dubius*.

"In red to light brown soil with few rocks," roadside near Leesankhu village, Chowtara District, Nepaul, July-August, Prof. K. N. Sharma, 4 clitellate or partially clitellate specimens.

Description: *External characteristics* (Chowtara specimens).—Length to 420 mm. Greatest diameter, to 13 mm. Dark blueish grey to blueish dorsally; lighter but also pigmented ventrally; clitellum, reddish.

The setae begin on segment ii; v/106, viii/10, ix/124, xii/117, xx/101.

The first dorsal pore is in 5/6.

The clitellum probably extends over xiii-xx but the epidermis of xii and xx or xxi-xxiii may be slightly modified and reddened; intersegmental furrows 12/13 and 18/19 or 20/21-22/23 are much deeper than on the region between.

The spermathecal pores are transverse slits close to the midventral line, two pairs in 7/8-8/9, each pore surrounded by a circumferential lip.

The single female pore is presetal on xiv.

The male pores are minute, transverse slits, 2-2½ mm. apart (9-10 intersetal intervals as measured on xix), within the depressed male shield, posterior to the setae of xviii and about in line with 18/19 which (as well as 17/18) is not visible on the male shield. The pores are quite some distance behind the setae of xviii as the setal line is bent forward in a crescentic fashion with the concavity posteriorly and the anteriormost point about in line with 17/18. The whitened genital shield (male area) extends across xviii and onto xvii and xix and is transversely

oval to longitudinally oval, sharply marked off except in the immediate vicinity of the setal line of xviii where the boundaries are very indistinct or lacking. The surface is cross hatched by numerous furrows producing a warty or minutely lobulated appearance.

Internal anatomy.—(Opened 2 specimens).

The gizzard is in vi, massive and firm. The gut begins to widen gradually in xix, reaching the full width in xx.

The last pair of hearts is in xiii (2).

The male funnels in x and xi are large, several times the size of the female funnels in xiii. Testes are present in both x and xi. The seminal vesicles of xi and xii are horse-shoe-shaped, on the posterior faces of 10/11 and 11/12 to which they are firmly attached ; in the anterior portions of segments xi and xii. The prostates are probably confined to xviii but bulge 17/18 and (or) 18/19 anteriorly and posteriorly. The prostatic duct is almost straight, thickish, slightly widened ectally. The posteriormost portion of the vas deferens is nearly one half the thickness of the prostatic duct.

There are no vesicular structures in xiii.

The smooth, glistening spermathecal duct is definitely marked off from the ampulla and is about two thirds to three quarters the length and thickness of the ampulla. Towards the parietes the duct begins to narrow and within the parietes is much slenderer but still muscular so that it can easily be pulled out from the body wall. No trace of a diverticulum was found on any of the eight spermathecae.

No penial setae were found in the coelom as in *P. excavatus* and other species of the genus. However, in separating the muscle fibres a number of branched objects were found, embedded in the parietes just anterior to the male pores ; so placed that the long axis is perpendicular to the ventral surface. These branched structures were broken in attempting to dissect them out. Under the microscope these bodies have an appearance very similar to if not exactly like that that of setae (*vide* text fig. 8).

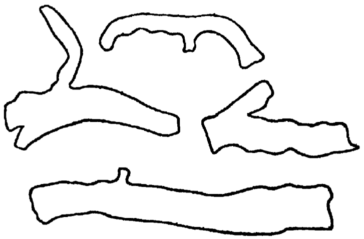

FIG. 8.—*Perionyx macintoshii.* Setal fragments from ventral body wall of xviii. × ca. 80.

For a discussion of the synonymy and status of *P. macintoshii*, see Stephenson 1931, p. 175 and p. 184.

Stephenson's 1917 specimens are probably abnormal ; male pores on xix. The male shield is very similar to that on Prof. Sharma's specimens but is less extensive and appears to be incompletely developed.

With regard to the aclitellate, Cherrapunji specimen Stephenson noted (1924, p. 341) that "The male area was much less marked" than on previous specimens. Presumably this is due to immaturity. The male field on the Cherrapunji specimen (of *P. macintoshii*) is almost exactly the same as that on the holotype of *M. dubius*. On both of these specimens the male field is a transverse depression on xviii posterior to the midventral setae which, at least in *M. dubius*, are dislocated anteriorly. The type of *M. dubius* is likewise aclitellate. The differences between the male field of *M. dubius* and the male field of fully clitellate specimens of *P. macintoshii* can accordingly be interpreted as due merely to difference in age.

Referring again to the type of *M. dubius*. The setal numbers according to Stephenson's count (v/91, ix/88, xix/*ca*, 81) are nearer to those of Prof. Sharma's specimens of *P. macintoshii* than are the setal numbers of either of Stephenson's 1917 or 1924 specimens and are also somewhat nearer than are the setal numbers of Beddard's specimen (*vide* Stephenson 1931). Furthermore: the gut is slender, long and bent in xviii, the intestine commencing in xix; the last pair of hearts is in xiii; the seminal vesicles of xi and xii are horseshoe-shaped and attached to the posterior faces of 10/11 and 11/12; the prostates are confined to xviii—the ducts short, straight, muscularly thickened and glistening ectally; penial setae, lacking. So far as all these characteristics are concerned the worm is like *P. macintoshii*. In *M. dubius* according to Stephenson the gizzard is in v and vi. Actually it is the thickened septum 6/7 that passes mesially to the gizzard. Quite possibly this septum can be dissected off from the posterior portion of the gizzard though this was not attempted because of the importance of the specimen. If the septum can be dissected off the location of the gizzard in segment vi will be another point of agreement with *P. macintoshii*. The spermathecae of *M. dubius* are not visible internally according to Stephenson so that comparison with the spermathecae of *P. macintoshii* is not possible. However it is quite evident that there is a very remarkable similarity in many points of systematic importance between *P. macintoshii* and *M. dubius*.

The latter species was placed the genus *Megascolex* because of the presence of "micronephridia." Bahl (*Q. J. M. S.* LXX, 1926) has shown however that the excretory tubules in the holotype of *M. dubius* are open, exonephric nephridia. In *Perionyx* the excretory organs (with the single rather dubius exception of *P. annulatus*) are open and exonephric but are large and there is only a single pair per segment. The differences in size and number of the nephridia do not appear to be as important as the similarities (*i.e.*, the possession of integumentary nephridiopores and preseptal funnels).

Perionyx sp. ?

Material examined.—Gurjung, Khare and Phoktey villages, Nepal, August and September, Prof. K. N. Sharma, 15 aclitellate specimens with spermathecal pores. (21 specimens without spermathecal pores possibly belong also to the same species.)

External characteristics.—Length, to 60 mm. Greatest diameter, to 5 mm. As a rule dorso-ventrally flattened, widest portion the middle

of the body. Anterior to xii or xi the worms are reddish, dark reddish, or blueish ; posterior to those segments, unpigmented, greyish.

The setae begin on segment ii. The setal numbers are shown below.

v.	vii.	viii.	ix.	xii.	xx.
37	21	20	45	41	44
40	18	18	47	51	45
46	25	26	49	51	47
39	19	20	49	48	46
	17	19			
	22	24			

(vii-viii spermathecal setae.)

The first dorsal pore is in 4/5 (8), 5/6 (3), in 5/6 but with a pore-like marking in 4/5 (3), in 7/8 (1).

Segments xii-xvii are whitened on some of the specimens but the clitellar glandularity is probably not fully developed on any of these.

The spermathecal pores are minute, widely separated, three pairs, in 6/7-8/9 ; the body wall in the immediate vicinity of the pores variously swollen.

The female pores are paired on xiv, presetal, about in line with or very slightly median to *a*.

The male pores were not positively identified but what appear to be vestiges of the male pores are about 5-6 intersetal intervals apart (as measured on xix).

The genital markings are transversely oval, whitened areas, paired on xviii, almost in contact at the midventral line and protuberant in a convex fashion. The setal circle of xviii may be continued in a straight line across these areas or the setae may be zigzagged in such a way as to produce an appearance of two rows.

Internal anatomy.—Septa are present from 5/6 posteriorly.

The rudimentary gizzard is anterior to 5/6. The intestine begins rather gradually in xvi. The gut in xv is narrow, unusually long for the length of the segment and consequently bent.

The last pair of hearts is in xii in each specimen.

The male funnels and testes are naked, in x and xi. The seminal vesicles of xi and xii are horse-shoe-shaped, attached firmly to the posterior faces of 10/11 and 11/12 and in the anterior portions of their segments. The prostates are confined to xviii. The prostatic duct is 2-4 mm. long, the ectal portion stronger than the ental portion and usually glistening.

The spermathecal duct is bulbous, almost spheroidal. The ampulla is rudimentary, shorter and slenderer than the duct.

Remarks.—The rudimentary appearance of the spermathecal ampullae seems to indicate that the worms are not fully developed. There are numerous protozoan cysts and nematodes in the coelom of the segments behind xviii. Possibly in *Perionyx*, as in *Pheretima*, a heavy infestation is able to affect or retard the development of some of the secondary reproductive organs.

Subfamily **Octochaetinae.**

Genus **Octochaetoides** Michaelsen.

Octochaetoides birmanicus Gates.

1926. *Octochaetus (Octochaetoides) birmanicus* Gates, *Ann. Mag. Nat. Hist.* (Ser. 9) XVI, p. 55.

Material examined.—"From the edge of a tank near Kinchana," near Amingaon, Kamrup Dist., Assam, April 5, 1924, S. L. Hora, 139 clitellate and 2 aclitellate specimens.

External characteristics.—The length varies up to 110 mm., and the maximum diameter up to $4\frac{1}{2}$ mm. The brown colouration characteristic of the Burmese specimens is lacking but this may be due to solution of the pigment by the preservative.

The setae begin on segment ii; $ab < cd < bc < aa$ represents the setal ratios most frequently observed, *cd* and *bc* may however approximate to equality, though both remain smaller than *aa*.

The clitellum is annular, extending from 12/13 to 16/17 or onto xvii, occasionally reaching to 17/18. On xvii the clitellar glandularity is developed only dorsally and dorsolaterally. Intersegmental furrows and dorsal pores are lacking, except that the pore belonging to 16/17 is often functional even when the clitellar glandularity extends posterior to 16/17. All setae are present on the clitellar segments.

The first dorsal pore is in 12/13 in all cases noted (25).

The female pores are closely paired, in *aa* on small circular areas of especial whiteness, 125 specimens; a single, median, female pore at the centre of the whitened area, 16 specimens.

The minute spermathecal pores are on viii and ix; each pore in the transverse setal line and about in *ab* though setae *a* and *b* of viii and ix are displaced, *a* usually median and posterior to its normal location, *b* often anterior and lateral to its normal location. Each spermathecal pore is at the centre of a tiny, transversely oval to circular area which is removed when the spermathecal duct is pulled out of the parietes.

The genital shield (male area) is protuberant and convex, or protuberant but flat or with two definite, transverse depressions on the shield as previously figured (Gates, 1930, p. 326). The latter more nearly approximates the appearance in the living Burmese worms, the protuberant conditions doubtless the result of varying reactions at time of killing and preserving. The seminal grooves are as in the Burmese specimens. One worm has an unusually long seminal groove on the right side, the groove extending onto segment xx. (In this worm there are three prostates and three bundles of penial setae on the right side, the extra prostate is in segment xx.)

Genital markings are often lacking as in the Burmese forms but when present are posterior to the genital shield and usually unpaired. Each marking represents a slight thickening of the epidermis only (no glandular material extends through the parietes into coelom).

A marking is transversely oval or with more bluntly rounded or more finely pointed ends, with a greyish, translucent centre and an opaque, slightly more protuberant, cream-coloured rim. The markings are regarded as postsetal but intersegmental furrows are lacking or not clearly indicated on the midventral region so that in some cases the markings appear to extend posteriorly onto the next segment and

almost to the setae of that segment. Anteriorly seta *a* or both *a* and *b* may be incorporated in the margin of the marking. Laterally the markings extend to *a*, *b* or slightly lateral to *b*. The number varies. On 44 specimens the markings are as follows: Unpaired: on xx, xxi and xxii—18 specimens; on xx and xxi—13 specimens; on xx—7 specimens; on xxi—2 specimens. Paired: on xx—4 specimens.

Internal anatomy.—(Opened 25 specimens.)

Septum 4/5 is present, muscular, funnel-shaped, the mesial point of the funnel directed posteriorly. The next septum definitely present is 8/9, septa 5/6-7/8 lacking or represented only by very fragmentary rudiments.

The intestine begins in xvii (25). The typhlosole, for 10-12 segments extending from xxiv or xxv to xxxiv or xxxvi, projects conspicuously into the gut lumen, the ventral portion separated more or less deeply into two lamellae. Behind this region the typhlosole continues posteriorly as a much less prominent ridge with only a faint line on the ventral face to mark the two lamellae.

Each specimen has a pair of calciferous glands in 15/16 extending into both xv and xvi. The gland is so placed that a larger and more dorsal portion is in xv with a smaller more ventral portion in xvi or *vice versa*. The condition on one side of the gut is the reverse of that on the opposite side.

The last pair of hearts is in xiii (25). There are paired hearts in each of segments ix-xii (25). Anterior to 8/9 the commissures and the longitudinal trunks except the ventrolaterals are usually empty and difficult to trace. In specimens in which the anterior vessels are filled with blood the following conditions have been noted. Anterior to the gizzard the dorsal trunk gives off a pair of vessels which have been traced to the ventral parietes but not to the ventral trunk. Posterior to the gizzard the dorsal trunk gives off two pairs of commissures. The anterior commissures have been traced to the ventral parietes but not to the ventral trunk. The posterior commissures can, as a rule, be traced readily to the ventral trunk. Just median to each of these posterior commissures (hearts of viii) is a commissural vessel which passes from the supra-oesophageal trunk nearly to the ventral parietes and then anteriorly as the ventrolateral trunk of its side. The supra-oesophageal trunk ends abruptly just anterior to these commissures. In two worms a definite pair of vessels passing from the dorsal trunk to the posterior margin of gizzard anterior to the commissures of vii has been observed.

The testis sacs are cylindrical formed by a thin, shortly cylindrical sheet of tissue passing from 9/10-10/11 or 10/11-11/12, testis sacs not opened by a careful mid-dorsal dissection. The hearts of x and xi are imbedded in the testicular material. The seminal vesicles are paired, in ix and xii (25). The vasa deferentia are conspicuously looped on the ventral parietes. In xvii the vasa pass lateral to the prostatic ducts, in xviii turning mesially and passing into the parietes about in line with the prostatic ducts. Deep within the parietes the vasa of a side unite.

In several specimens two setae, doubtless representing *a* and *b* of xviii have been found within the parietes on the median face of the

vasa. These setae are 0·31-0·36 mm. in length, ornamented with short, transverse rows or ridges of fine teeth, the bluntly rounded, ectal tip bent very slightly towards one side. These setae could not be found in the majority of the specimens but whether this is due to poor dissection or absence of the setae is not quite clear.

The penial setae are contained within connective tissue bands which are on the median faces of the prostatic ducts, the ental ends of the bands passing to the parietes dorsolaterally. Each seta has a bluntly rounded tip and is usually ornamented by longitudinal rows of 4, 5, 8 or more triangular teeth. Rarely a seta may be quite smooth (*i.e.*, without dental ornamentation). Occasionally only 1, 2 or 3 teeth can be recognized.

Just behind each spermathecal duct is a Y-shaped mass of connective tissue inverted so that the paired arms pass to the ventral parietes, one just lateral to and one just median to the spermathecal duct while the tail of the Y passes to the parietes dorsolaterally. In the paired arms of the Y are the copulatory setae. The ectal tip of a copulatory seta is sharply pointed and rather diamond or spear-head-shaped. The shape of the setae is such that when they are placed on a slide they rest thereon with the ornamented portions laterally. The ornamented portions are very refractive. After treatment with strong corrosives two longitudinal, closely placed rows of thorny or spinous projections can be readily seen, at either side of the shaft. Occasionally slight traces of transverse membranes between pairs of spines can be seen. If these membranes are actually parts of the setae the ornamentation at the sides can probably be described as a longitudinal row of pouch or stirrup-like pockets, the apertures of which face towards the ectal tip of the shaft.

Both pairs of spermathecae are anterior to 8/9 (25). The spermathecal duct is elongate and barrel-shaped, narrowed just below the ampulla and just before passing into the parietes. The roughly spheroidal diverticulum passes by a short and slender stalk into the duct just ventral to the ampullary constriction.

Remarks.—In the coelom of one of the aclitellate specimens are large numbers of protozoan cysts. The reproductive organs of this worm are apparently fully developed and of normal appearance though there is no trace of clitellar glandularity.

O. birmanicus is most closely related, apparently, to *O. surensis* (Michaelsen) 1910, from which it is distinguished mainly by the absence of septum 7/8.

Genus **Eutyphoeus** Michaelsen.

Eutyphoeus assamensis Stephenson.

1926. *Eutyphoeus assamensis*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 262.

Material examined.—Seventeen specimens labelled "W 1951/1. *Eutyphoeus assamensis* Steph. Katlicherra, S. Cachar, Assam. S. L. Hora. March 1925."

A.

The spermathecal pores are small, transverse slits in 7/8, about in *b* or very slightly lateral to *b*. On xvii there is a pair of smooth, glisten-

ing, circular areas that extend from *a* into *bc*. At the centre of each of these areas and about in *b* there is a very small, transversely slit-shaped aperture through which, on some of the specimens, penial setae project.

The transversely oval, postsetal genital markings are on xvi, each marking just behind *ab*, reaching slightly median to *a* and slightly lateral to *b*, the median margin slightly nearer to the midventral line than the median margin of a marking on xvii. The genital markings are present on 12 of the 13 specimens under consideration.

The dorsal blood vessel is continued anteriorly into the pharyngeal region with fairly large commissures in v and paired hearts belonging to vi at the anterior end of the gizzard.

Lateral intestinal caeca are lacking (2). The unpaired ventromedian intestinal caeca are in xxxvi-xlvi (1).

Segment xi is apparently not closed off from the parietes laterally and ventrally though 10/11 and 11/12 are in contact dorsally. The testicular material surrounds the gut and the dorsal blood vessel.

The spermathecal duct is glistening and barrel-shaped. On the lateral and median side of each duct near the ental end is a small diverticulum.

The bulbous ejaculatorius is definitely coelomic.

Remarks.—The clitella are not well developed on any of the specimens, as was noted by Stephenson.

B.

On three specimens including the single dissected specimen the circular areas on xvii are lacking but in their place is a narrow, transversely elongated depression that extends laterally nearly to *c*. Towards each lateral margin of this depression there is a very small slit through which the penial setae project. At each end of the depression there is a u-shaped, rather conspicuously protuberant ridge, the limbs of the u short and reaching midventrally only to *a*.

The dorsal blood vessel is continued anteriorly at least to 5/6 with hearts belonging to vi at the anterior end of the gizzard.

The unpaired, ventromedian, intestinal caeca are in xxxvi-xlv (1).

The spermathecal ducts are not so well developed in these specimens and the bulbous ejaculatorius projects less conspicuously into the coelom.

Remarks.—Stephenson's description of the species is based on specimens with u-shaped ridges. So far as can be determined from an examination of segment xi these specimens are not as mature as those without the ridges. The reason for the statement that the dorsal blood vessel "ends behind the gizzard" is not obvious.

It is possible that two distinct but closely related species are represented in these two groups.

Eutyphoeus gigas Stephenson.

Material examined.—One specimen labelled, "W 73/1. *Eutyphoeus gigas.* Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart. Type."

On 19/20 there are slight indications of special glandularity that may represent genital markings, extending from *a* or slightly lateral to *a* into mid *bc* on each side.

The ventral intestinal caeca are in xxxiii, xxxiv (?), xxxv-xlvii. The lateral caeca are well developed; the caecum of one side directed dorsally, of the other side anteriorly into xxv.

The hearts of xi are bound down to the gut but the testicular material is ventral to the oesophagus.

There is a definite but short and stoutish spermathecal duct, probably narrowed in the parietes.

Remarks.—The type is hard and strongly contracted and in this condition the determination of certain important characteristics involves risk of damaging or breaking the specimen.

E. gigas is probably close to *E. longiseta* and *E. rarus* and may actually be conspecific with one of the Burmese forms but the relationships cannot be determined until further material from Rangamati is available for study.

Eutyphoeus lippus, sp. nov.

Material examined.—" In dark brown soil intermixed with rocks and stones" Gurjung, Khare and Phoktey villages, Ramechap District—East 2, Nepaul, August and September, Prof. K. N. Sharma, 2 clitellate, 6 partially clitellate and 133 aclitellate specimens.

Description: *External characteristics.*—Length, to 120 mm. Diameter, 4-6 mm. Unpigmented, clitellum reddish.

The setae begin on ii; on segment xx the setal distances can usually be represented by the formula $ab < cd < bc < aa$, but *cd* and *bc* may occasionally be equal or nearly equal; *bc* may be one half, two thirds, or three fourths of *aa*.

The first dorsal pore is located as follows: in 7/8 (1), in 8/9 (3), in 8/9 but with a distinctly pore-like marking in 7/8 (3), in 9/10 (4), in 9/10 but with a definitely pore-like marking in 8/9 (3) or with pore-like markings in 7/8-8/9 (4), in 10/11 (4), in 10/11 but with a pore-like marking in 9/10 (8) or with pore-like markings in 8/9-9/10 (3) or with a pore-like marking in 7/8 only (2) or with markings in 7/8-8/9 (4).

The clitellum extends from mid xiii to 16/17 or dorsally and laterally only to mid xvii; intersegmental furrows and dorsal pores lacking.

The spermathecal pores are transverse slits, in *ab* or extending from *a* or from mid *ab* into *bc* or mid *bc*.

The female pores are paired on xiv, each pore just anterior and median to *a*.

On xvii, on each side there is a shallow, rather slit-like depression, about in *ab*. The whitish margin of this depression may be slightly protuberant as a smooth or lobulated circumferential lip. In the depression but really a part of the anterior lip is a shortly transverse tubercle or papilla. The median margin of the tubercle reaches practically to the median margin of the depression but the lateral margin may not quite reach to the lateral margin of the depression. On this tubercle there are either two penial setae or two setal pits. The penial setae are almost but not quite as widely spaced as setae *a* and *b* on xvi or xviii. The peni-setal tubercle is always definitely marked off by a slight furrow. At the bottom of the transverse depression and usually towards the lateral side there can be seen on favourable specimens two pores,

one of which is slightly lateral to the other. These pores are presumably the male and prostatic pores. Just anterior to each peni-setal tubercle is a small, transversely oval genital marking (probably on the anterior portion of xvii). Immediately posterior to each depression is a similar marking, probably on the posterior portion of xvii. Every specimen has these two pairs of markings though the markings may be only faintly indicated on the smallest of the aclitellate specimens.

The preclitellar genital markings are a pair of nearly circular areas on x, each area in *ab* and delimited by a slight furrow or (aclitellate specimens) by a fine greyish line (140 specimens). On one specimen the marking of the right side is lacking. A posterior portion of x including the ventral setae on its anterior margin and also including the genital markings may be protuberant as a transversely placed, dumb-bell-shaped area.

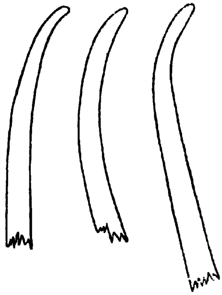

FIG. 9.—*Eutyphoeus lippus.* Tips of penial setae. × *ca.* 80.

Internal anatomy.—(Opened 95 specimens.)

The intestine begins in xv (95). The lateral intestinal caeca are paired, in xxiv, each caecum a dorsally directed flap with a bluntly rounded tip, flattened against the oesophagus (67). The median caeca are located in segments xxx-xxxvii as shown below.

Segments.	Specimens.
xxx-xxxiv	7
xxx-xxxv	7
xxx-xxxvi	1
xxxi-xxxiv	5
xxxi-xxxv	15
xxxi-xxxvi	5
xxxi-xxxvii	1
xxxii-xxxv	2

The dorsal blood vessel is continued into the pharyngheal region (95). Paired commissures belonging to v-xiii are present (94). In one worm the right commissure of v is lacking. All commissures of v-xiii pass into the ventral blood vessel (5).

There are no male funnels in x or seminal vesicles in ix (95). The seminal vesicles of xii push 12/13 and 13/14 back into contact with

14/15. The testis sac (xi) is in the form of a horse-shoe on the oesophagus, the dorsal blood vessel and the hearts imbedded in the testicular coagulum (95). In several specimens dissected from the ventral side no transverse communications between the ventral ends of the limbs of the horseshoe were visible but this may not always be the case. The prostates are in xvii-xviii. The prostatic duct is 3-5 mm. in length. The bulbus ejaculatorius is small, short and softish but coelomic. The penial setae pass into the parietes median to the prostatic duct while the bulbus passes into the parietes immediately posterior to the prostatic duct.

The spermathecal duct is short but stout, easily pulled out from the parietes within which it is not narrowed. Each spermatheca (189) has a median and a lateral diverticulum. In one specimen the median diverticulum of the left spermatheca is lacking. The diverticula are usually elongate, and may be said to be finger shaped but in a number of specimens the ental end of the diverticulum is bilobed. The diverticula are usually bent posteriorly, but in very small specimens may project straight out from the lateral and median faces of the duct.

There is a whitish (glandular ?) material projecting slightly into the coelom through the parietes over each genital marking on x and also but less conspicuously, xvii.

Remarks.—The worms are rather brittle and break easily. In a number of specimens the gut is macerated in the region immediately behind the prostates. The handling of specimens in such condition is not easy; the determination of the position of the first dorsal pore is especially difficult. Very slight pressure is sufficient to force fluid out through the dorsal pores in the region just anterior to the clitellum. In front of the first dorsal pore, as indicated by the exertion of very slight pressure, there are usually several pore-like markings. Further pressure often breaks the worms without indicating whether or not these additional markings are also pores.

The position of the lateral intestinal caeca could not be determined in a number of specimens because of the decay of the intestine.

A number of aclitellate specimens appear to be otherwise fully sexual. The seminal vesicles are well developed; the testis sacs are filled with testicular coagulum; within the spermathecal ducts are masses of iridescent material (spermatozoa ?) which extend externally through the spermathecal pore and internally into the lumen of the spermathecal ampullae. In the smallest aclitellate specimens the seminal vesicles are well developed but the prostates and spermathecae are small.

In some of the smallest aclitellate specimens there are numbers of parasites scattered throughout the coelom of the segments behind the prostatic region. Each parasite is surrounded by a thickish layer of a pearly iridescence and contains a single ovoidal nucleus within which is an eccentric endosome.

Aclitellate specimens of *Eutyphoeus* from Jata Pokhrie and Panch Pokhrie in Ramechap District may perhaps be also referable to *E. lippus.* These particular specimens were collected at an altitude of 13,000-15,500 feet and were found in a thin layer of mud on rocks covered

over by lichens. In this thin layer of "mud" there were also found some clitellate Lumbricids. The latter were very badly preserved and were not identified.

E. lippus is probably close to *E. nepalensis* but is distinguished from the latter by the absence of postclitellar markings, by the presence of preclitellar markings and by the simpler, undivided condition of the paired spermathecal diverticula.

Eutyphoeus manipurensis Stephenson.

Material examined.—One undissected and two dissected specimens labelled "W 553/1. *Eutyphoeus manipurensis* Steph. Swamps round Thānga Island in Loktak Lake, Manipur. Manipur Survey."

The circular to longitudinally oval male pore markings on xvii are more deeply retracted into the parietes than on the Burmese specimens (*vide* Gates, 1933, p. 583). The annular lip-like margins of the depressions produced by the retraction are in contact at the midventral line. Within each depression are two softish protuberances, the posterior rounded and much larger than the other which is anteroposteriorly flattened. On the anteroventral margin of the posterior protuberance there is a very small, transversely slit-like pore. At the bottom of the slit between the two protuberances is a transversely oval, smooth, glistening papilla on which two setal pits are visible.

The dorsally or ventrally directed, lateral, intestinal caeca are in xxvii on the anterior face of 27/28 except on one side of one specimen where the caecum is in xxvi.

The spermathecal diverticulum is on the lateral side of the duct which is fairly thick. The ampullae are filled by a greyish-brown, granular material.

Eutyphoeus nepalensis Michaelsen.

Material examined.—One specimen labelled, "*Eutyphoeus nepalensis* Michlsn. ZEV 2880/7. Chitlong, Nepal. Mus. Coll. (R. Hodgart) Type" and from the Hamburg Museum, two dissected and 1 undissected clitellate specimens labelled. "V 7131. *Eutyphoeus nepalensis* Michlsn. Hodgart. Nepal."

Vestibula and penes are lacking. The male porophores are transversely oval, thickened areas on xvii which are fairly widely separated midventrally. On each of these areas there is a transversely slit-like aperture. Within the slit are the penial setae which pass into the anterior wall of the invagination where they are separated from each other by a septum. At the bottom of the invagination there is a single, minute, but readily recognizable pore, in line with the lateral penial seta, the pore a trifle larger than the aperture of the setal pit.

The genital markings are transversely oval and protuberant in a convex fashion, paired, separated midventrally; on 19/20-20/21.

The lateral, intestinal caeca are small, dorsally directed; in xxiv. The ventral caeca are in xxxi-xxxv. The dorsal blood vessel is continued anteriorly into the pharyngeal region with paired hearts belonging to v, vi, vii and viii.

The testis sac is annular, the hearts of xi and the dorsal blood vessel surrounded by testicular material. The seminal vesicles of xii push 12/13 and 13/14 into contact with 14/15. The bulbus ejaculatorius is coelomic and passes into the parietes just posterior to the prostatic duct. Penial setae are present; the ectal ends ornamented but the tips softened and probably deformed.

The spermathecal diverticula are in two groups, one group on the lateral face of the spermathecal duct, the other on the median face.

Glandular material projects through the musculature into the coelom over the genital markings.

Remarks.—The penial setae were overlooked by Michaelsen.

E. nepalensis is probably close to *E. lippus* but can be distinguished at present by the characteristics of the genital markings and the spermathecal diverticula.

Eutyphoeus sp. ?

Material examined.—Happy Valley, near Shillong, Nov. 11, 1930, H. S. Rao, 1 aclitellate specimen.

Length, 190 mm. Maximum diameter, 8 mm. Unpigmented, no trace of clitellar glandularity.

The setae are very small and retracted, $aa > bc$. The first dorsal pore is in 13/14 but there is a tiny, dark spot, somewhat pore-like, in 12/13.

Tiny grey spots in 7/8 in *b* probably represent the rudiments of the spermathecal pores.

On the middle annulus of xvii there is a narrow, transverse depression with a rather tumid circumferential lip, extending laterally on each side to slightly beyond *b*. On the roof of this depression on each side and about in line with *b* is a tiny, transversely oval, slightly protuberant, whitish papilla at the centre of which is a pit or pore. There is a transversely depressed groove in the region of 19/20 much like the groove on xvii but without the tumid lip.

Lateral intestinal caeca are lacking; three tiny, whitish, ventral caeca were found in the region of segments xxxvi-xxxviii. The dorsal trunk ends with the hearts of vii.

The seminal vesicles are fairly large, the right vesicle confined to xii but folded in a pleated fashion, the left vesicle extending into xiii. The bulbus ejaculatorius is well developed, ovoidal.

The spermathecal ampulla is elongately saccular; the duct short but thickish; the diverticula are paired.

THE FISH OF CHITRAL.

By SUNDER LAL HORA, *D. Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plates III and IV.)

In the summer of 1929, a small party of the Zoological Survey of India was sent to Chitral to investigate the zoology and anthropology of the country. At the same time, Dr. G. Morgenstierne of Oslo, after obtaining permission and necessary facilities from the Government of India, went to Chitral to study the languages, folklore, custom and dramatic performances of the Kafirs of Kafiristan. The zoological section of the party, which worked under the leadership of Dr. B. N. Chopra, visited several places in the valley and made extensive collection of fish, besides that of other animals.

According to the Imperial Gazetteer of India,[1] Chitral is a state in the Dir, Swat and Chitral Agency of the North-West Frontier Province and lies between 35° 17′ and 37° 8′N. and 71° 22′ and 74° 6′E.; it has an approximate area of 4,500 square miles. The state is bounded on the north by the Hindu Kush range, on the west by Badakhshan and Kafiristan, on the south by Dir and on the east by the Gilgit Agency, Mastuj and Yasin. Generally, Chitral, like Kafiristan "consists of an irregular series of main valleys, for the most part deep, narrow, and tortuous, into which a varying number of still deeper, narrower, and more difficult valleys, ravines and glens pour their torrent waters. The mountain ranges which separate the main drainage valleys from one another are all of them of considerable altitude, rugged and toilsome."[2] (Pl. iv, figs. 1, 2.) The Chitral River, which is the principal river of the valley, is formed by the union of two large streams, the Lutkuh from the north-west and the Mastuj from the north-east (pl. iv, fig. 2). These streams arise along the southern slopes of the Hindu Kush and join each other about four miles above the town of Chitral. The Chitral River (Plate iii) flows almost due north and south and is joined by a number of streams along its course; these are the Rambhur and the Bomboret joining near Ayun, the Shishi joining near Drosh and the Lahozai joining near Mirkhani. At this place the river takes a south-west course and at Arnawai (or Arandu, as it is known locally) it passes out of the Chitral territory. In its lower reaches it is called the Kunar River and joins the Kabul River near Jallalabad. The banks are for the most part steep and high, but in places the river flows through a broad and fertile valley and its water is extensively used for irrigation. During summer months the river carries a very large amount of silt in suspension giving the water a distinctly reddish tint, on account of the colour of the soil over which it flows.

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[1] *Imp. Gazetteer of India*, X, p. 301 (1908).
[2] Robertson, *The Kafirs of the Hindu-Kush*, p. 66 (London: 1896).

The tributaries of the Chitral River, such as Lutkuh and Mastuj flow through deeper valleys and amid more precipitous hills. In consequence, the nature of their beds and the swiftness of their currents correspond more closely with the torrential streams on the southern slopes of the Himalayas. A brief description of the various streams, in which collection of fish was made, is included under the list of localities (*vide infra*, pp. 283-285).

The ichthyology of Chitral proper has never been studied before, though Griffith in his travels through Afghanistan made a collection of fish in the Kunar River near Jallalabad and remarked that "The fish of the Koonur River, the largest tributary of the Kabul River, so far as I know, are all characteristic of Afghanistan, consisting of a Barbus with an elongated body, enormously developed fleshy lips, the lower being three-lobed, another Barbus, and one or two Oreini".[1] The two species of 'Barbus' referred to in Griffith's notes are evidently *Schizothorax labiatus* (McClelland) and *Sch. esocinus* Heckel, and the *Oreinus* is probably *O. sinuatus* var. *griffithii* McClelland, a very variable form as is clear from Dr. Chopra's collection from the Chitral Valley. Besides these three species, Dr. Chopra collected a large series of specimens of *Glyptosternum reticulatum* and of a new species of *Nemachilus*. It is probable that the two latter species are characteristic of swift currents and are not found in the Kunar River at Jallalabad, where several Indian species were also collected by Griffith in the Kabul River.

Robertson[2] observed that the rivers of Kafiristan "teem with fish which no Káfir could be persuaded to eat. The people declare that fish live on dirt, and shudder at the idea of using them for food, as we would shudder at the idea of eating rats". Griffith[3] also noticed that "The fish of Afghanistan, except perhaps those of the valley of Peshawar, cannot be considered as administering to any extent to the food of the inhabitants. It is only about Jallalabad, and more especially along the Koonur valley, that I have seen Afghans employed in fishing. The only nets in use are common casting nets, but this method did not appear to me so successful as that of the hook and line".

Dr. Chopra also observed that "the Káfirs do not eat fish, though the Red Kafirs are now taking to it. They catch fish with their hands by feeling under stones and rocks. They also put a basket under a fall in the course of a stream (pl. iv, fig. 3) and drive fish down into it with their hands and feet working under stones and thus driving the fish out". The common cast net is also employed for catching fish, but these are all very primitive methods and show that the fish are not in much demand in the valley.

As is characteristic of the fish-fauna of any particular valley in Central Asia, the fauna of Chitral is poor in the number of species, only five having been found as enumerated above; while the number of individuals of each species, with the exception of *Schizothorax esocinus*, is very large indeed. *Sch. esocinus* is represented in Dr. Chopra's collection

[1] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).
[2] Robertson, *The Káfirs of the Hindu-Kush* p. 68 (1896).
[3] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).

by a single specimen and is probably a casual visitor to the valley from the lower reaches of the Chitral River. The paucity of species of fish in the valleys of Central Asia is probably due to several causes, the most important of these, however, seems to be that the waters of the valleys have been colonised[1] gradually by the migration of fishes from neighbouring territories. I have already pointed out that "there is no indication in this fauna which shows that it is indigenous and that it has not been derived from the fauna of the low-lying lands of the neighbouring countries". The valleys themselves contain, as is indicated below in the short descriptions of the stations in the Chitral Valley, a fair diversity of habitats to permit a certain amount of 'ecological segregation' to take place so as to influence the production of new species; but the factors that inhibit the multiplicity of species are very powerful indeed. In the first place, access to the valleys of Central Asia to the south of the Hindu Kush is through the tempestuous torrents that flow all along the slopes of the Himalayas, and it will be admitted that the conditions of life are very exacting in these swift and turbulent waters. In consequence, *Nemachilus*, *Glyptosternum* and the Schizothoracinae are the only fish that have been able to invade the higher altitudes and establish themselves in the valleys of Central Asia. It was pointed out by Griffith (*op. cit.*) that some species of Indian fish extend in the Kabul River up to Jallalabad, to the north of which the fauna, so far as the fish are concerned, is typically Central Asiatic. It seems probable, therefore, that the small torrential streams along the southern slopes of the Himalayas form effective barriers for the penetration of sluggish-water species from India and other countries. In the Chitral Valley, there are places where *Barbus*, *Cirrhina*, *Labeo*, etc., if introduced, would probably flourish, but in the normal course these genera have no chance to reach the valley. The species, that were able to cross the barrier, found rich feeding grounds and vast tracts of unoccupied territory. In accordance with biological laws, they multiplied and occupied every suitable niche in the environment and even though they still exhibit marked habitat preference, they developed a certain amount of tolerance for variation in the intensity of environmental factors. This can be clearly seen from the lists of species given below under each station.

The best adapted torrential fish in Chitral is *Glyptosternum reticulatum*; it feeds on insect larvae, such as the Ephemeropterous nymphs of *Iron* and Blepharocerid larvae, which live on or under rocks in very swift currents. *Oreinus*, which is confined usually to the rapids, is a bottom feeder and takes up food indiscriminately, though it seems to feed mainly on the algal matter encrusting rocks and stones in swift currents. *Schizothorax esocinus* is carnivorous, feeding on young fish and decaying flesh; while *Sch. labiatus* feeds on algae, caddis-worms and other insect larvae. Both species of *Schizothorax* live in deeper waters of large rivers and can withstand fairly swift currents. *Nemachilus choprai* lives among rocks and pebbles at the bottom and feeds on algae and insect larvae. From an ecological study of the fish fauna of three Central

[1] Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 268 (1930).

Asiatic rivers, Nikolski [1] has shown that "there are well-marked communities of species associated with different rates of flow of rivers". It has been shown by me [2] that the rate of flow of water is the principal ecological factor that determines the types of association of animals in mountain streams. According to the rapidity of the current, the five Chitral species can thus be arranged in a series: *Glyptosternum reticulatum*, *Orienus sinuatus* var. *griffithii*, *Nemachilus choprai*, *Schizothorax labiatus* and *Schizothorax esocinus*. From certain stations two or more species were collected, but it should be remembered that habitats vary sometimes within a very short distance of one another in the same environment. The five species from Chitral, though superficially they seem to live together, do not appear to compete with one another either for food or for space. The slow waters in Chitral, especially those containing a rich growth of vegetation, seem to be the haunts of young specimens and are, no doubt, the nurseries of the Chitral species.

As has been remarked by Griffith (*op. cit.*), the fish of the Kunar River are all characteristic of Afghanistan. *Sch. labiatus* is widely distributed in Afghanistan both in the Kabul and the Helmand river systems; *Sch. esocinus* is found in the Kashmir Valley and in the Kabul and the Helmand river systems of Afghanistan; *Oreinus sinuatus* var. *griffithii* is also found in the Kabul and the Helmand river systems of Afghanistan and *Glyptosternum reticulatum* has a much wider range of distribution. being found in the head-waters of the Indus, the Kabul, the Syr-Darya and the Amu-Darya rivers. The only endemic species in Chitral is *Nemachilus choprai*, which, in general facies, is very much like its congeners of Central Asia. On account of its close resemblance to *N. kashmirensis* Hora,[3] a full description, with figures, of the latter species is included here to facilitate reference.

Dr. Chopra observed that the fish were most abundant at the junctions of the side streams with the main river. During my recent visit to the Tista Valley in May-June 1934, I noticed that the fish were to be found in large numbers at the junction of the Kalijhora stream with the Teesta river. During my brief stay at Kalijhora, it rained heavily and the water of the river was very muddy. The water of the Kalijhora stream was black. I was informed that the black colour was due to certain friable rocks that lie in the bed of the stream. The black stream did not mingle with the muddy water for about a hundred yards. According to the popular belief the fish like the taste of this water and in consequence gather in large numbers at the junction of the two streams. It is difficult to say, whether there is any truth in this belief or not but there seems no doubt that the small streams flowing through deep, forest-covered valleys bring down large quantities of vegetable débris and detritus with them, especially after heavy rainfall. This leads to a great increase in the available food supply and at the same time large quantities of nutrient salts, derived from the soil, are brought down with the current. Another possible factor is that the waters of the small streams, on account of the tempestuous nature of their currents, are

[1] Nikolski, *Journ. Animal Ecology* II, pp. 266-281 (1933).
[2] Hora, *Phil. Trans. Roy. Soc. London* (B) CCXVIII, pp. 171-282 (1930).
[3] Hora, *Rec. Ind. Mus.* XXIV, p. 76 (1923).

much more highly oxygenated than those of the main stream. These are some of the possible factors that may account for the abundance of fish at the junctions of small streams with the principal river of a valley.

Reference may here be made to another observation which Dr. Chopra made in the Chitral Valley. On the 24th and 25th of July 1929, Dr. Chopra was camping between Daimali and Karakal in the Bumboret Valley. The Bumboret is a large river formed of a number of snow-fed streams; it has a rocky bed and the water is usually clear. During Dr. Chopra's stay, there was a heavy rainfall in the valley and in consequence the river was flooded. The intensity of the flood was so great that bridges were washed away down the valley and considerable damage was done. The water rose very high in the river and became turbid and muddy. These abnormal conditions must have incommoded the fish, as with the subsidence of water they were found washed along the banks in a dead or dying condition. The majority of these consisted of *Glyptosternum reticulatum* and the only other fish found on the banks was *Oreinus sinuatus* var. *griffithii*. Both the species are specially adapted to adhere to rocks in swift currents and have undergone structural modifications for this purpose; they are not capable of sustained swimming, though they can dart from rock to rock with great rapidity. It seems reasonable to presume that fishes with such habits, once dislodged from their moorings, either by the swiftness of the current, by the disturbance caused by the suspended pebbles and stones in the current or by the choking effect of muddy water in respiration, are probably carried helplessly in deep water by the flood till they are washed on the banks. A number of fishes picked up by Dr. Chopra were merely stupified and were revived by keeping in water. There are previous records of similar happenings in Central Asia and other mountainous countries. Lt.-Col. F. M. Bailey once sent me specimens of *Nemachilus* picked up by him after heavy floods from the bank of a stream in Eastern Tibet.

The following is a list of stations whence Dr. Chopra collected fish in the Chitral Valley. Short descriptions of the stations from Dr. Chopra's field notes and lists of species of fish collected at each station are given.

Sta. 1. 20th-28th June, 31st July and 1st-3rd August, 1929. Chitral or Kunar River near Chitral town.

"A large and broad river of muddy water flowing over a bed of sand and mud with some stones and boulders. The current is moderately swift and the banks are in most places steep and rocky. There is no vegetation in the water."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax esocinus* Heckel.
iii. *Schizothorax labiatus* (McClelland).
iv. *Oreinus sinuatus* var. *griffithii* McClelland.
v. *Nemachilus choprai*, sp. nov.

Sta. 2. 1st-3rd July and 19th July, 1929. Pallarga stream about 2 miles below Kunisht (Red Kaffir village) in the Rambhur Valley.

"A small stream of clear, rapidly flowing water over stones and rocks in a somewhat north to south direction and joining the Rambhur River

almost midway between Kunisht and Rambhur. Practically no plant life in water, though some trees and shrubs on the banks, which are quite steep in places. The water is considerably warmer than that in the Rambhur River or other streams in the locality." At 12 noon on the 19th of July 1929, the temperature of water in the Pallarga stream was 71·0 F. while that of Rambhur River was only 57°·0 F.

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 7. 24th and 25th July, 1929. Bumboret River between Daimali and Karakal in the Bumboret valley.

" A large river formed of a number of snow-fed streams, running for the most part from south-west to north-east and joining the Rambhur River a few miles above Ayun before falling in the Chitral River. It has a very swift current of clear water flowing over stones and boulders and irrigates by means of side channels an extensive area of land." Heavy floods killed the fish and washed them up the banks.

i. *Glyptosternum reticulatum* McClelland.
ii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 8. 4th August, 1929. Lutkuh River at Sheghor.

" A very large stream of moderately swift current with water almost dark with suspended mud and clay, flowing over a more or less sandy bed, with comparatively few stones and boulders. No vegetation in the stream."

i. *Schizothorax labiatus* (McClelland).

Sta. 9. 5th and 6th August, 1929. Lutkuh River near Hot-Springs.

" A large stream of rapid current with clear water flowing over a bed of stones and sand. No vegetation."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.
iv. *Nemachilus choprai*, sp. nov.

Sta. 12. 20th-27th August, 1929. Mastuj River between Koghazi and Mastuj.

" A large river of muddy water and swift current flowing for the most part over stones and boulders, with occasional patches of sand and mud, between steep banks. No vegetation of any kind in the water."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.
iv. *Nemachilus choprai*, sp. nov.

Sta. 13. 29th August, 1929. A small stream near Surguz in the Mastuj Valley.

" A stream of clear water, originating from some springs and fed by other springs along its course, with a moderately swift current flowing

over a bed of sand and stones, and with plenty of vegetation consisting of grasses and algae."

i. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 14. 30th August, 1929. A small stream above Charun in the Mastuj Valley.

"The stream is fed by a number of springs along its course, has clear water with plenty of vegetation and a bottom of mud and sand with a few stones."

i. *Nemachilus choprai*, sp. nov.

Sta. 15. 6th and 10th September, 1929. Small spring-fed streamlets between Tar and Drosh.

"Small streams of clear water, and slow current used in some places for irrigation, with plenty of vegetation and a somewhat muddy bottom."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 16. 15th and 16th September, 1929. Ramram gol near its junction with the Chitral River below Arandu.

"A large hill stream of clear water, with swift current flowing over stones and boulders and without any vegetation."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Before giving the systematic account of the collection, I wish to express here my sincerest thanks to Dr. B. N. Chopra for the valuable information he has supplied to me during the preparation of this report and for his helpful suggestions and to Dr. B. Prashad for going through the manuscript. Mr. R. Bagchi has made all the drawings, except those of *Nemachilus kashmirensis* Hora, under my supervision with great care and skill and for this I am much obliged to him.

Glyptosternum McClelland.

1842. *Glyptosternon*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
1860. *Glyptosternon*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 152.
1876. *Exostoma*, Day (in part), *Fish. India*, p. 501.
1889. *Exostoma*, Day (in part), *Faun. Brit. Ind. Fish.*, I, p. 108.
1889. *Glyptosternum*, Vinciguerra, *Ann. Mus. civ.-stoz. Nat. Genova*, XXIX, p. 245.
1905. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 182.
1911. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 564.
1922. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXIV, p. 33 (foot-note).
1923. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXV, p. 30.
1923. *Glyptosternum*, Annandale (in part) *Ann. Mag. Nat. Hist.* (9), XII, pp. 573-577.
1925. *Parexostoma*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
1931. *Glyptosternum*, Myers, *Lingnan Sci. Journ.*, X, p. 260.
1932. *Glyptosternum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, pp. 176-179.
1933. *Glyptosternum*, Smith, *Journ. Siam Soc., Nat. Hist. Suppl.*, IX, pp. 70-74.
1933. *Glyptosternum*, Berg, *Poiss. Eaux Douces, U. R. S. S.*, 3rd ed. pt. ii, p. 590.

In 1922 and more particularly in 1923, I assigned to the genus *Glyptosternum* a group of Sisorid fishes in which the structure of the paired fins agrees with McClelland's description of the fins of *G. reticulatum*. This structure is so remarkable that Blyth seems to have been greatly influenced by it in restricting the name *Glyptosternum* to *G. reticulatum*, which thus constitutes the type of the genus. Though at the time, I was fully aware of the heterogenous nature of the assemblage I referred to *Glyptosternum*, it was not possible then to divide it into genera as the name *Glyptosternum* could not be applied to any of the forms with certainty. Regan [1] and Myers (*op. cit.*) have also indicated that until *G. reticulatum* is rediscovered and redescribed it is not possible to arrive at a satisfactory solution concerning the application of this generic name. Recently, however, I gave reasons to believe that "*Parexostoma stoliczkae*," a widely distributed species in the western parts of Central Asia, is identical with *Glyptosternum reticulatum*, and pointed out that of the several genera, into which Glyptosternoid fishes have been divided, *Parexostoma* Regan becomes synonymous with *Glyptosternum* McClelland. This supposition has received further support from the fact that McClelland's species have been rediscovered [2] from the Kabul River near Kabul in Afghanistan. The Surgeon to the British Legation at Kabul made a small collection of fish in the Paghman River, a tributary of the Kabul River, and this included a specimen of *Glyptosternum reticulatum* (or the hitherto well known species *Parexostoma stoliczkae*). This discovery leaves no doubt about the identity of McClelland's *G. reticulatum* described from Sir-i-Chashma, the source of the Kabul River. From within the limits of Afghanistan the species has also been obtained in the Bannu Anderab River [3] of the Oxus System, about 79 miles north of Kabul. Both Smith and Berg in their recent works have upheld my views regarding the generic identity and limits of *Glyptosternum* McClelland. In view of this evidence it is now possible to split up the composite assemblage and to define the generic limits of each group. The genus *Glyptosternum* may be characterized as follows :—

The genus *Glyptosternum* comprises large-sized and greatly flattened Sisorid fishes in which the head and the anterior part of the body are depressed and the tail is compressed from side to side. The skin is soft except on the ventral surface in front of the anal-opening where it is thickly or sparcely covered with soft papillae. The eyes are minute, almost indistinguishable; they are subcutaneous and are situated on the dorsal surface of the head. The mouth is transverse and is situated considerably behind the tip of the snout. The teeth are pointed, those of the upper jaw form a band which is produced backwards at the sides. The teeth on the lower jaws form two bands which are pointed towards the sides. The fold of the lower lip is broadly interrupted. There are 8 barbels, 2 nasal, 2 maxillary and 4 mandibular ; the mandibular barbels are provided with very broad bases and on the ventral surface in their

[1] Regan, *Ann. Mag. Nat. Hist.* (9), XI, p. 609 (1923). Berg (*Bull. Acad. Sci. U. R. S. S.*, p. 1267, 1931) used the name *Glyptosternum* for species of the genus *Glyptothorax* Blyth.

[2] Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697 (1933).

[3] Hora, *ibid.*, XXXVII (*in press*).

outer halves bear striated pads of adhesive skin. The gill-openings are wide, extending to the ventral surface for a short distance. The gill-membrane is broad and free throughout its length. The fins are "without spines, the first ray of the pectoral and ventral fins soft and pinnate, giving off soft, pointed cartilaginous rays along the anterior margin, which are enveloped in the membrane of the fin". The dorsal is situated above or slightly behind the pectorals, but entirely in advance of the ventrals. The adipose fin is long and low. The paired fins are broad, rounded and horizontally placed; they are vertical in their inner and horizontal in their outer halves. The skin on the ventral surface of the first ray of the paired fin is corrugated in pinnate folds for the purposes of adhesion. The caudal fin is truncate, obliquely truncate or somewhat rounded. The air-bladder is greatly reduced and enclosed in two bony capsules.

Type-species.—*Glyptosternum reticulatum* McClelland.

In view of the uncertainty prevailing about *G. reticulatum* I[1] suggested in 1923 that *G. labiatum* McClelland should be considered as the type of *Glyptosternum* instead of *G. reticulatum*. Myers[2] has pointed out that this suggestion is in violation of the International Rules of Zoological Nomenclature, but in view of the rediscovery of *G. reticulatum* no new genotype need be considered.

Geographical Distribution. So far only two species are known in this genus. *Glyptosternum maculatum* (Regan) is known from Eastern Tibet (Lhasa and Gyang-tse) and Sikkim; whereas the other species *G. reticulatum* McClelland is widely distributed in the head waters of the Indus (Basgo, Sneema, Leh, Ladak and the Kashmir Valley), of the Kabul River (Sri-i-Chushmah, Julraiz[3], Paghman and the Chitral Valley), of the Syr-Darya and the Amu-Darya in Eastern Turkestan (Oxus System).

Glyptosternum reticulatum McClelland.

1842. *Glyptosternon reticulatus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
1860. *Glyptosternon reticulatus*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 153.
1876. *Exostoma Stoliczkae*, Day, *Proc. Zool. Soc. London*, p. 782.
1877. *Exostoma Stoliczkae*, Day, *Fish India*, p. 502, pl. cxvii, fig. 3.
1878. *Exostoma Stoliczkae*, Day, *Sci. Res. 2nd Yarkand Miss.*, Ichthyology, p. 1, pl. i, fig. 1.
1889. *Exostoma Stoliczkae*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 110, fig. 45.
1889. *Exostoma Oschanini*, Herzenstein, *Mel. biol.*, XIII, p. 69.
1890. *Exostoma Oschanini*, Herzenstein, *Bull. Ac. St. Petersburg*, XXXIII, p. 120.

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[1] Hora, *Rec. Ind. Mus.*, XXV, p. 35 (1923).

[2] Myers, *Lingnan Sci. Journ.*, X, p. 260 (1931).

[3] According to Day (*Ichthyology Sci. Res. 2nd Yarkand Miss.*, p. 19, 1878, foot-note), Griffith's remark (*Calcutta Journ. Nat. Hist.*, II, p. 564, 1842) regarding the most remarkable "dark coloured Loach-like *Silurus*, which is not uncommon about Julraiz" probably refers to a species of *Amblyceps*. In my revision of the genus *Amblyceps*, I have indicated (*Rec. Ind. Mus.* XXXV, p. 610, 1933) that *Amblyceps* has never been recorded from any place west of the Kangra valley. I am of opinion that in his remark about "Loach-like *Silurus*" Griffith made a reference to *Glyptosternum reticulatum* which is found in abundance at Sir-i-Chashma.

1905. *Exostoma Stoliczkae*, Berg, *Ryby Turkestana*, p. 211, fig. 31.
1905. *Parexostoma Stoliczkae*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 183.
1907. *Exostoma gracile*, Grazianov, *Trudy Otdela Ichtyologii*, IV, p. 58.
1907. *Exostoma labrax*, Grazianov, *ibid*, p. 59.
1908. *Exostoma stoliczkae*, Berg, *Ezhegodnik Zoologicheskago Muzeya Akademii Nauk*, XIII, p. 450 (1908).
1916. *Parexostoma stoliczkae*, Berg, *Poiss. Eaux Douces Russie*, p. 371, figs. 289, 290.
1923. *Glyptosternum stoliczkae*, Hora, *Rec. Ind. Mus.*, XXV, p. 37.
1925. *Parexostoma stoliczkae*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
1932. *Glyptosternum reticulatum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, p. 179, fig.
1932. *Glyptosternum reticulatum*, Hora, *Cur. Sci.*, I, p. 130.
1933. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697.
1933. *Glyptosternum reticulatum*, Berg, *Poiss. Eaux Douces U. R. S. S.*, 3 ed. pt. ii, p. 597, figs. 549-551.
1934. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVII (*in press.*)

From the above synonymy it is clear that *Glyptosternum reticulatum*. instead of being an obscure species as hitherto believed to be, is a well-known representative of the Sisorid group of fishes. Several authors have described it and published its illustrations under the title "*Exostoma stoliczkae*". I, therefore, do not propose to redescribe the species here, but in view of the abundant material before me from the Chitral Valley the following notes should prove useful.

Day (1876) has already indicated the remarkable variation in the comparative length of the head to that of the total length in this species. I have noticed that such a range of variation exists in the relative proportions of all the principal organs. For instance, the length of the caudal fin is contained 6·4—9·8 times in the total length including the caudal. In smaller individuals this fin is relatively longer. The head is also proportionately longer in young individuals; the length of the head is contained 4·9—6·2 times in the total length with the caudal and 4·2—5·6 times without it. The depth of the body is also variable but it is not in any way correlated with the size of the specimen; it is contained 7·3—10·5 times in the total length with the caudal. The caudal peduncle becomes proportionately longer with the growth of the fish; its least height is contained 2·6—3·4 times in its length. The increase in the length of the fins does not keep pace with the growth of the fish. In young specimens the pectorals are separated from the ventrals by a short distance, and the latter are separated from the anal by a still shorter distance. While in fully grown examples these fins are considerably removed from one another. The longest ray of the dorsal is greater than the depth of the body in specimens up to 110 mm. in length while in larger specimens it is considerably shorter than the same dimension. For further details reference may be made to the table of measurements on page 291. It seems probable that the variability of the species has led to its being described under so many different names in various parts ot its extensive range of distribution.

Distribution.—It has been pointed out above (p. 287) that *Glyptosternum reticulatum* is widely distributed in the upper reaches of the Indus, the Kabul, the Amu-Darya and the Syr-Darya Rivers. Thus the species is found in Eastern Turkestan and in the mountain regions that border

it on the south and west. In the Chitral Valley, Dr. Chopra obtained 215[1] specimens from the following localities :—

(i) 37 specimens from the Chitral River near the Chitral town (Sta. 1).
(ii) 18 specimens from the Pallarga Stream 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
(iii) 154 specimens from the Bumboret River between Daimali and Karakal (Sta. 7).
(iv) 2 specimens from the Lutkuh River near Hot-springs (Sta. 9).
(v) 1 specimen from the Mastuj River between Koghazi and Mastuj (Sta. 12).
(vi) 1 specimen from a small spring-fed stream between Tar and Drosh (Sta. 15).
(vii) 2 specimens from the Ramram gol stream near its junction with the Chitral River below Arandu (Sta. 16).

It is clear from the above that *G. reticulatum* is found all over the Chitral Valley and that it is abundant in large rivers and streams. Dr. Chopra has observed that the species is commonly found near the junction of the side streams with the principal river of the valley. Owing to the heavy floods in the valley, a large number of fish were washed on the banks of the Bumboret River and were picked up next day in an almost dead condition.

Berg remarks that *G. reticulatum* (= *Parexostoma stoliczkae*) 'lives under stones'. Dr. Chopra has also observed that in the Chitral Valley the fish lives in fair numbers under stones and rocks. The species lives in large and clear streams with rapid-flowing current and with the bed strewn with rocks and boulders. Except for the algae and slime that cover the rocks in such situations, Dr. Chopra did not observe any vegetation in most of these streams. The nature of the food of these fishes (*vide infra*, p. 290) shows that they brouse over the exposed surface of rocks where they must live under the direct influence of the swift current. So it seems probable that a bed of smooth rocks is essential for these fishes, that their feeding grounds are the exposed surfaces of rocks and that they seek shelter under rocks when frightened or when not feeding. These habits correspond very closely to those of the fishes of the genus *Garra* and other hill-stream fishes.

Sexual Dimorphism and the Proportion of Sexes in the population.—In *Glyptosternum reticulatum* the males do not possess any well-marked secondary sexual characters; but by dissecting a number of specimens, I have been able to find some difference in the region of the anus by which the sexes can be distinguished readily by a superficial examination of the specimens. Behind the anal opening, there is a deep groove. In the male a sharp, conical, well-developed papilla projects behind the anus in this groove; whereas in the females, there is no anal papilla but the anal opening is bordered laterally by two prominent lips which cover the groove behind the anus. Judging by these characters, I have been able

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[1] In my note on *G. reticulatum* in the *Annals* I mentioned only 176 specimens. Unfortunately, I overlooked to count the specimens in one bottle. Four specimens have been presented to the British Museum (Nat. Hist.), two were sent to Dr. G. S. Myers and a dozen specimens to the Zoological Museum at Moscow.

to divide the 209 specimens into 122 males and 87 females. So far as can be judged by these figures, it seems that males predominate in the population; they form 58·4 per cent as against 41·6 per cent females. Of the 148 specimens from the Bumboret River (6 specimens from this locality have been presented to outside institutions) there are 78 males and 70 females giving a percentage of 52·7 males and 47·3 females. As has been indicated above, these specimens were picked up from the banks of the river after a heavy flood. In these circumstances the males and females must have been equally affected and judging from the above figures there is only a negligible higher percentage of males over the females. The figures indicate that the males and females occur in almost equal proportions. The females are probably less active and of more secretive habits than the males and this would account for the preponderance of males over females from other localities. The samples are, however, not sufficiently large to permit of any generalisation.

Bionomics.—The alimentary canal is not very much convoluted: its length is 0·94 of the total length of the fish. On an examination of the stomach-contents of about a dozen and a half specimens, it was found that the fish feeds on the flattened larvae of Ephemeroptera, such as *Iron* and other Heptageniid larvae, and the *Ephemerellid* nymphs, on the larvae and pupae of Trichoptera and the larvae and pupae of Blepharoceridae. Among the stomach-contents were a few other larvae of the *Baetis*-type (Ephemeroptera) as well as Chironomid and other highly specialised Dipterous larvae. The major part of the food consists of the Heptageniid nymphs of the *Iron*-type. All these insect larvae are specially adapted to live on or under the exposed surfaces of rocks in very swift currents,[1] in fact the Blepharocerid larvae cannot live and have not yet been found in slow currents. It is reasonable, therefore, to conclude that *Glyptosternum reticulatum* frequents exposed, smooth surfaces of rocks in swift currents for the purpose of feeding and that it also searches for the Heptageniid nymphs under stones. The relatively large size which this species attains (Day's largest example was 175 mm. in length, Berg had examples 215 mm. in length and in the present material the largest example is about 230 mm. in total length) shows that it lives in somewhat deeper waters, for large size is a distinct disadvantage in shallow waters. The fish is perfectly adapted for the type of habitat depicted above. Its flattish ventral surface can be closely applied to the hard substratum and by means of the broad, corrugated, outer ray of the paired fins it adheres to rocks. The structure of its paired fins further shows that the fish vigorously pumps out any water that flows on its under surface thus creating a negative pressure for the purposes of adhesion. The broad and reflected lips and the broad maxillary barbels with corrugations on their ventral surface help in adhesion. There is also no doubt that the papillae on the ventral surface are used for the same purpose. The large and unspecialised gill-openings show that the fish breathes continuously; but its large gill-membrane would indicate

[1] Hora, "Ecology, Bionomics and Evolution of the Torrential Fauna," *Phil. Trans. Roy. Soc. London* (B), CCXVIII, pp. 171-282 (1930).

Measurements in millimetres.

	Sta. 2. ♂					Sta. 16. ♂		Sta. 7. ♀		Sta. 7. ♂	
Total length including length of caudal	81·8	84·5	89·0	134·2	147·5	101·8	105·5	160·0	164·5	207·0	225·5
Length of caudal	10·7	10·9	11·8	21·0	20·0	14·0	14·0	19·5	20·3	24·0	23·0
Length of head	16·6	16·5	17·0	26·4	29·0	20·0	21·0	28·8	30·0	38·2	36·0
Width of head in front of pectorals	14·7	15·2	16·0	25·0	28·0	19·2	19·0	27·6	29·2	34·8	36·4
Height of head at occiput	8·8	8·1	8·8	12·7	13·0	10·4	10·1	15·0	15·0	16·8	20·0
Depth of body	9·0	8·9	10·0	17·6	17·6	11·8	12·8	15·2	22·4	26·0	23·2
Length of snout	8·8	8·4	8·8	13·2	16·0	10·8	10·0	14·5	14·6	20·0	18·5
Interorbital width	5·0	4·6	6·0	8·0	9·0	5·8	5·2	9·0	8·7	10·5	11·0
Length of caudal peduncle	16·0	18·2	19·0	28·0	30·0	21·0	20·5	33·0	36·5	48·6	51·0
Least height of caudal peduncle	6·0	6·7	7·1	9·1	10·3	7·0	6·2	10·0	10·5	15·0	16·0
Longest ray of dorsal	13·2	12·0	13·5	16·8	17·2	13·5	13·2	15·0	16·0	22·2	23·0
Longest ray of anal	11·2	10·8	11·6	16·5	18·0	11·7	12·2	16·0	16·0	19·4	22·0
Length of pectoral	19·0	19·3	21·0	30·0	33·3	21·6	22·7	35·0	35·3	39·2	43·0
Length of ventral	15·2	15·0	17·0	23·6	24·5	17·7	17·2	27·0	25·6	29·2	33·3

that the respiration is initiated and carried on by its flapping movements. On rocks the fish seems to crawl with the help of its paired fins by using them alternately and it is likely that the lips and the associated structures also help during progression. Its powerful and muscular tail is no doubt used for darting movements from rock to rock. *G. reticulatum* is a bottom-dwelling fish, and is not capable of sustained swimming in swift currents. It is probable that the broad, lunate band of teeth on the upper jaw is used for rasping off from the rocks encrusting organisms of the type of Blepharocerid larvae and nymphs of *Iron*, etc. The teeth on both the jaws are sharp and pointed and are directed backwards. Between these two sets of teeth the scraped food has little chance to escape. The gill-rakers are long, broad and pointed, and are closely set; they decrease in size on the posterior gill-arches.

In 1923, I (*op. cit.*, p. 34) expressed the opinion that "*Glyptosternum stoliczkae*" and *G. maculatum* represented the less specialized members of the assemblage denominated as '*Glyptosternum*,' and from the simple nature of the lips and mouth, tooth-bands, gill-openings, paired fins and general facies I was misled to regard them as ancestral forms of Glyptosternoid fishes. Later work[1] has shown that on account of life in deeper and less turbulent waters of the Highlands of Central Asia as compared with those of the small Himalayan streams, *G. reticulatum* has assumed a mask of apparent simplicity and that its simple organisation is the result of retrogression and in no way represents a truly primitive or ancestral condition. These conclusions are borne out by the type of streams in which specimens of *Glyptosternum* were collected by Dr. Chopra in the Chitral Valley.

Local Name. -According to Dr. Chopra *Glyptosternum reticulatum* is known as *Karmatchhi* among the Kafirs.

Schizothorax labiatus (McClelland).

1842. *Racoma labiatus*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 578, pl. xv, fig. i.
1842. *Schizothorax Ritchieana*, McClelland, *ibid.*, p. 580.
1868. *Racoma labiatus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 162 (foot-note).
1868. *Schizothorax ritchianus*, Günther, *ibid.*, p. 168.
1877. *Schizothorax Ritchianus*, Day, *Fish. India*, p. 531 (foot-note).
1877. *Schizothorax labiatus*, Day, *ibid.*, p. 532 (foot-note).

McClelland's description and figure of *Schizothorax labiatus*, though meagre and inadequate, are sufficiently clear as regards the most distinctive feature of the species--the nature of the lips. Since McClelland's original account, no observations seem to have been made on *Sch. labiatus*, owing to the fact that no specimen was hitherto available for study. The species was described from Griffith's drawing and the specimens, which were "accidentally left behind with the Ornithological portion of the collection" by Griffith, seem to have been lost in transit. McClelland's characterisation is as follows:

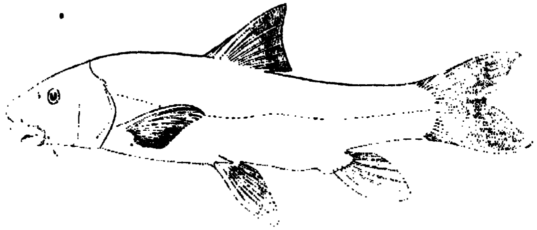
"Length of head greater than depth of body, and equal to a fourth of the entire length. Inter-maxillary very protractile and covered with a thick adipose integument, *a thick trilobed integument to the lower jaw*, cirri terminating in trident points.

[1] Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 237 (1930).

D. $\frac{3}{8}$: P. 19: V. 10: A. 7.

Intestine short, disposed in $3\frac{1}{2}$ or four double folds.

Habitat.—Pashut, Koonar River near Jallalabad.—Griffith's Mss. Mr. Griffith remarks that this singular form is nearly allied to the Lalpore species, but that the intestines of the latter are infinitely longer, nor is there any enlargement of the lips in the latter; but this last character Mr. Griffith remarks is not so remarkable in young specimens." (Italics are mine).



TEXT-FIG. 1.—Lateral view of a large specimen of *Schizothorax labiatus* (McClelland) from the Pallarga stream (Sta. 2) ×$\frac{1}{2}$.

As a rule, in *Schizothorax* the lips are moderately fleshy and it is only in a few characteristic species that they are greatly enlarged. So far as I am aware the lips are hypertrophied in *Sch. regelli* Herz.,[1] of which a single specimen is known from the Amu-Darya, and in *Sch. baileyi* (Lloyd)[2] known from two specimens collected at Gyangtse, Tibet. Whereas in these two species the posterior lip is bilobed, in *Sch. labiatus* it is trilobed and forms a very characteristic feature of the species. In another species *Sch. ritchieana*—described by McClelland from Afghanistan, the lower lip is trilobed. It is characterized as: "*Reflected posterior margin of the lower lip trilobate*; lips broad, round and soft; width of the mouth equal to about $\frac{1}{2}$ the length of the lower jaw; which is narrow at the apex; snout narrow and compressed; dorsal spine large, scales very small, lateral line raised, body spotted." (Italics are mine). In a large series of specimens collected by Dr. Chopra from the Chitral Valley, there are quite a number of specimens in which the lower lip is greatly enlarged, whereas in the majority of specimens the lips are of the *ritchieana*-type. Moreover, all possible gradations are found in the collection before me between the two types of lips. Fortunately McClelland sent a specimen of *ritchieana* to the Museum at the India House whence it was transferred to the British Museum and later served for Günther's description of the species in the *Catalogue*. The Chitral specimens agree with Günther's description and there seems to me no doubt that *Sch. labiatus* and *Sch. ritchieana* are synonymous. Both

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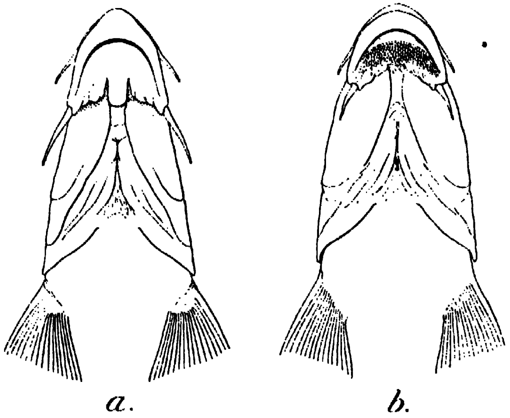
[1] Herzenstein, *Fische*, in *Wiss. Res. Przewalski Central-As. Reis. Zool.*, III, pl. ix, fig. 1. According to Berg (*Poiss. Eaux Douces U. R. S. S.* 3rd Ed., pt. 1, p. 458, 1932), *Sch. regelli* is a synonym of *Sch. fedtschenkoi* Kessler and that the enlarged lips are of the nature of secondary sexual characters of the male. In *Sch. labiatus* both sexes possess enlarged lips.

[2] Lloyd, *Rec. Ind. Mus.*, II, pl. xxv, fig. 2 (1908).

McClelland and Günther observed that in the Helmand River examples the dorsal spine is relatively small. The Chitral collection shows that the dorsal spine is very variable in this species. In certain examples it is strong and well developed, whereas in others it is rather feeble and flexible. But in every case, it is conspicuously serrated posteriorly.

Day included *Sch. labiatus* in the group of species characterized by the "Lower labial fold interrupted", but this is obviously wrong.



TEXT-FIG. 2.—Ventral surface of head and anterior part of body in two specimens of about equal size of *Schizo thorax labiatus* (McClelland) showing variation in size and form of lower lip; etc., $\times \frac{2}{3}$.

a. True *labiatus* type; *b. ritchieana* type.

In a number of young specimens it is observed that the condition of lips and jaws is intermediate between *Schizothorax* and *Oreinus*. Such a condition appears to have resulted from hybridisation (*vide infra* p. 307).

McClelland, on the observations of Griffith, stated that *Sch. chrysochlora* has much in common with *Sch. labiatus*. The resemblance is probably closer with the specimens of *Sch. labiatus* in which the lower lip is not well developed. The two species can, however, be readily distinguished by the following features:—

In *Sch. labiatus* the body is more slender and the head is considerably pointed; the labial fold is well developed and prominently trilobed; the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin, and the anal scales are very small, considerably less than half the diameter of the eye.

Schizothorax labiatus may be redescribed as follows:—

D. 3/8; A. 3/5; P. 18-20; V. 11-12; C. 20.

Schizothorax labiatus is a narrow, elongated species in which the body is subcylindrical and both the profiles are slightly arched. The ventral

surface of the head and the anterior part of the body are flattish. The head is large and pointed anteriorly; its length is contained 3·7—4·4 times in the total length without the caudal. The width of head is almost equal to its height at the occiput and is contained 1·6—1·7 times in the length of the head. The snout is smooth, but in some specimens it is studded with sharp, wart-like protuberances. These structures are usually characteristic of the males but certain ripe male specimens were without them. The eyes are placed laterally slightly below the dorsal profile of the head and are not visible from the ventral surface; they are situated in the middle of the head or slightly nearer to the tip of the snout than to the posterior margin of the operculum. The diameter of the eye is contained 5·3—7·6 times in the length of the head, 2·1—3·3 times in the length of the snout and 1·7—2·5 times in the interorbital width. The interorbital space is flattish and is marked with a short, longitudinal bony ridge in the middle with two other low ridges on the sides. The mouth is inferior, horizontal and greatly arched; it is bordered by thick and fleshy lips which are continuous at the angles of the mouth. The lower lip is trilobed, the side lobes are free while the middle lobe is only free at the tip. The structure of this lip is subject to great variation as indicated above (*vide supra*, p. 293). The lower jaw is sharp, shovel-like and covered with a thick, horny sheath. There are two pairs of well developed barbels which are longer than the diameter of the eye. The gill-openings are moderately extensive.

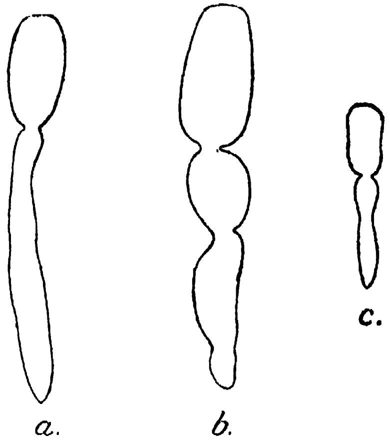
The depth of the body is contained 4·4—5·6 times in the total length without the caudal; it is covered with small scales which are inconspicuous on the ventral surface in front of the ventral fins. The lateral line is slightly raised and there are about 107 scales along it and 28 rows between it and the base of the dorsal spine. The tiled row of anal scales is rather indistinct; the largest scale being less than half or about half the diameter of the eye.

The commencement of the dorsal fin is opposite to that of the ventral and is almost equidistant between the tip of the snout and the base of the caudal fin. The dorsal spine is strong and horny or feeble; its length in middle-sized specimens is contained 1·0—1·2 times in the length of the head. In older specimens the spine is proportionately shorter, its length being contained 1·6 times in the length of the head. The spine is strongly serrated posteriorly. The posterior margin of the dorsal fin is slightly emarginate. The pectoral fin is shorter than the head and its outermost ray is the longest; it is separated from the ventral by a considerable distance. The anal opening is situated at the base of the anal fin and is considerably removed from the ventral fin. The anal fin, when laid flat, does not reach the caudal fin. The caudal fin is deeply emarginate. The caudal peduncle is strong and muscular; its least height is contained 1·5—1·9 times in its length.

In very young specimens the body is marked with short, black streaks. In half-grown and adult specimens the body is uniformly silvery with a slightly darker tint on the dorso-lateral surface of the body.

Air-bladder.—The air-bladder of *Schizothorax labiatus* shows considerable variation as regards the form of the posterior chamber. In adult examples the walls of the bladder are thickened, fibrous and

inelastic. The anterior chamber is of the normal Cyprinoid form, whereas the posterior chamber is long and narrow. In one specimen the posterior chamber was found to be constricted in two places asymmetrically so that the bladder appeared four chambered. In a young specimen the posterior chamber was slightly narrowed in the middle. Similar variations also occur in the bladder of *Oreinus sinuatus* var. *griffithii*. The significance and the probable mode of origin of these abnormal types of bladders are discussed below (*vide infra*, p. 304).



TEXT-FIG. 3.—Air-bladders of 3 specimens of *Schizothorax labiatus* (McClelland) showing variation in form and structure. × ⅔. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

a. Normal type; from a specimen 350 mm. in length.
b. An abnormal four-chambered air-bladder from a specimen 325 mm. in length.
c. Air-bladder of a young specimen 160 mm. in length.

Distribution and Habitat.—*Schizothorax labiatus* was described from the Kunar River near Jallalabad, but the form *ritchieana* was stated to be fairly common in Afghanistan. Dr. Chopra's collection shows that the species is very common in the Chitral River and its tributaries. Specimens were obtained from the following localities:—

(i) 1 large specimen from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
(ii) 6 specimens collected at Chitral in August 1929.
(iii) 47 specimens from the Lutkuh River at Sheghor (Sta. 8).
(iv) 1 specimen from the Lutkuh River near Hot Springs (Sta. 9).
(v) 21 specimens from the Mastuj River between Koghzai and Mastuj (Sta. 12).
(vi) 28 very young specimens from a small stream between Tar and Drosh.
(vii) 11 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).

The larger individuals were obtained from rivers with swift current and rocky bed whereas the young specimens were collected in small streams. In young specimens the character of the lower lip is not so well developed as has already been remarked by Griffith. Both *Oreinus* and *Schizothorax* prefer large rivers with or without backwaters; the former is confined to these habitats whereas the latter occurs in lakes also. *Schizothorax* lives in rapids under stones and rocks.

Bionomics.—In young specimens the alimentary canal is about 1·5 times the total length of the fish and in a specimen about 300 mm. in length it was 2·3 times the length. The stomach was empty in most of the specimens dissected which suggests not only that feeding is intermittent but that the digestive action is fairly rapid. The alimentary canal was full of grayish pulp and pieces of gravel. It seems likely that *Schizothorax* feeds on caddis-worms, algae and insect larvae. The shorter length of its intestine shows that it is more carnivorous in its feeding habits than *Oreinus*. It seems likely that the broad lips of *Sch. labiatus* are spread out and applied to rocks for adhesive purposes. The horizontal paired fins and the flattish ventral surface are no doubt used for this purpose. The pointed and subcylindrical body of the fish is well adapted to offer less resistance to the rushing currents.

Measurements in millimetres.

Total length excluding caudal	184·5	215·0	243·0	262·0	350·0
Length of caudal	41·0	53·0	57·0	55·5	78·0
Length of head	42·5	51·0	58·3	59·0	93·0
Width of head	25·0	29·2	37·0	35·0	57·0
Height of head at occiput	26·5	30·3	37·8	37·0	54·0
Length of snout	17·0	21·0	23·0	26·0	41·3
Diameter of eye	8·0	8·0	10·0	8·4	12·2
Interorbital width	13·5	16·0	21·0	20·3	30·5
Depth of body	37·6	37·8	55·0	53·0	68·5
Length of dorsal spine	38·3	41·0	47·0	50·0	56·0
Length of pectoral	31·4	40·0	43·2	46·0	67·3
Length of ventral	30·6	37·6	41·5	42·0	63·0
Length of caudal peduncle	19·0	21·6	30·0	28·0	36·8
Least height of caudal peduncle . . .	40·5	40·0	46·0	52·0	66·7

Schizothorax esocinus Heckel.

1838. *Schizothorax esocinus*, Heckel, *Fische aus Caschmir*, p. 48, pl. ix.
1842. *Schizothorax esocinus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 579.
1844. *Schizothorax esocinus*, Heckel, *Fische Kaschmir*, p. 372, 3 figs.
1868. *Schizothorax esocinus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 166.
1876. *Schizothorax esocinus*, Day, *Proc. Zool. Soc. London*, p. 785.
1876. *Schizothorax punctatus*, Day, *ibid.*, p. 785.
1877. *Schizothorax esocinus*, Day, *Fish. India*, p. 533, pl. cxxiii, fig. 4.
1877. *Schizothorax punctatus*, Day, *ibid.*, p. 532, pl. cxxiii, fig. 3 (foot-note).
1878. *Schizothorax esocinus*, Day, *Sci. Res. 2nd Yarkand Miss.*, Ichthyology, p. 4, pl. i, fig. 4.
1878. *Schizothorax punctatus*, Day, *ibid.*, p. 4, pl. 1, fig. 3.
1889. *Schizothorax esocinus*, Day, *Faun. Brit. India, Fish.*, I, p. 254.
1889. *Schizothorax punctatus*, Day, *ibid.*, p. 252 (foot-note).
1910. *Schizothorax esocinus*, Zugmayer, *Zool. Jahrb.*, XXIX, p. 277.
1916. *Schizothorax esocinus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (3), VII, p. 20.

Both Zugmayer and Vinciguerra have referred at some length to the discrepancies in Day's descriptions, and to the inaccuracies in his drawings of *Schizothorax punctatus* and *Sch. esocinus*. From an examination of specimens in their possession they came to the conclusion that the two species are identical. The Zoological Survey of India possesses the originals of Day's figures of these two species, and a comparison of the specimens shows that Day, who probably did not possess a large series of specimens of *Sch. esocinus* to study its range of variation, had some justification to regard them as belonging to two species. Besides the differences in the general facies of the two specimens clearly shown in Day's delineations, they differ in the form and proportion of the head, the nature of the jaws, the extent and form of the mouth opening and the way in which the bones of the hyoid arch lie on the ventral surface of the head. The following table of measurements shows some of the salient differences between the two specimens :—

Measurements in millimetres.

	Sch. esocinus. (No. 678).	*Sch. punctatus.* (No. 511).
Total length excluding caudal	170·5	192·0
Length of head	46·0	59·5
Width of head	23·0	26·3
Height of head at occiput	23·7	30·0
Greatest diameter of eye	8·0	10·2
Interorbital width	13·2	19·3
Length of snout	15·5	20·8
Depth of body	32·2	34·2
Length of rostral barbel	10·0	9·0
Length of maxillary barbel	12·0	8·0
Length of caudal peduncle	30·0	35·0
Least height of caudal peduncle	16·0	17·2

Day's illustrations are inaccurate in several respects and it seems probable that he drew up his descriptions from the figures without reference to the specimens, otherwise it is not possible to believe how his descriptions could be so faulty and misleading. *Schizothorax esocinus* seems to vary considerably and when a number of specimens are examined the differences noted above between the two forms are bridged over. Sufficient material is not available to decide whether these differences are in any way related to the sexes of the individuals. Berg[1] has indicated that in the case of *Sch. fedtschenkoi* Kessler there may be great structural differences between the two sexes.

Griffith obtained specimens of *Sch. esocinus* in the tributaries of the Helmand and the Kabul Rivers in Afghanistan. In the Chitral Valley the fish is said to be very rare ; it is represented by a single specimen which was collected by Dr. Chopra from the Chitral River near the Chitral town. Dr. Chopra informs me that he made special efforts to obtain more specimens of this species but without any success. This example represents the typical *esocinus* of Day and in it the length of the head is

[1] Berg, *Abhandlungen der Pamir Expedition* 1928, VIII, p. 23, pl. ii, figs. 1 and 2.

contained 3·6 times in the total length without the caudal. The height of the head at the occiput is almost equal to the width of the head which is nearly half the length of the head. The diameter of the eye is contained 6·5 times in the length of the head, 2·2 times in the length of the snout and 1·9 times in the interorbital width. This specimen is about 275 mm. in length, but Dr. Chopra was informed that the species grows to a much larger size and is a very good eating fish. In comparison, it is considered to be a better fish for eating than other species of *Schizothorax* and *Oreinus* commonly met with in Chitral. In spite of its qualities of flesh, the local people consider it a foul feeder. The stomach contents of the Chitral example consist of a semi-digested young specimen of *Schizothorax* and plenty of dark-coloured gravel and sand. It is likely that this species lives in pools and puddles where it feeds on dead animal matter deposited at the bottom. Its jaws are somewhat protrusible so that it can probe about in the mud and suck in food mixed with gravel like some of the typical Cyprinid fishes. Enough material is not available, however, to make any detailed observations on the bionomics of this species.

Besides the specimens referred to above there are five other examples of *Schizothorax esocinus* from Kashmir in the collection of the Zoological Survey of India. These specimens were obtained in June-July 1921 by the Kashmir Survey Party. Of these, 3 comparatively young specimens up to 135 mm. in total length were obtained in the Jhelum River at Srinagar, one from Wular Lake and a large one from Gandarbal. These specimens show that the head is relatively longer in younger individuals; its length being contained 3·3—3·6 times in the total length without the caudal. The depth of the body is very variable, being contained 4—5·6 times in the length without the caudal. The eyes are relatively much larger in the young specimens; the diameter of the eye is contained 4·5—7·6 times in the length of the head, 1·5—2·5 times in the length of the snout and 1·2—2·1 times in the interorbital width. The caudal peduncle is narrower and longer in larger specimens, the least height of the caudal peduncle is contained 1·7—2·1 times in its length. The fins are nearer to one another in young specimens whereas in grown-up individuals they are situated more widely apart. The osseous and serrated ray of the dorsal fin is always longer than the postorbital part of the head; it is proportionately longer in the young specimens. The longest ray of the dorsal fin is contained 1·2—1·7 times in the length of the head. The young specimens are generally marked with largish black spots, while the larger specimens are covered with numerous black marks. The example from Chitral as well as the smallest specimen from Kashmir are without any marking. They are grayish above and silvery on the sides and below.

Remarks.—In describing *Schizothorax punctatus* Day referred to "*Racoma nobilis* McClelland" (*op. cit.*, p. 577), and remarked that it "has more fleshy lips, while the mouth appears more transverse, as in *Oreinus*, and the under jaw much the shorter". McClelland had no specimen of the species, but described it from Griffith's drawing. Day's remarks are also based on this illustration. *Schizothorax nobilis* is said to grow to a large size (18 inches) and its habits of preying on small fish

and feeding on offal show that it may prove to be identical with *Sch. esocinus.* Its body and fins are covered with spots as is usually the case in *Sch. esocinus.*

In the following table I give the measurements of the Chitral example as well as of the five specimens from Kashmir :—

Measurements in millimetres.

	Chitral.	Jhelum River.			Wular Lake.	Gandarbal.
Total length without caudal	224·2	95·0	107·3	110·3	191·0	273·0
Length of head	62·2	28·5	32·0	33·0	54·0	76·5
Width of head	31·5	13·3	18·3	16·3	26·0	39·5
Height of head	31·3	15·2	19·0	18·0	31·0	41·6
Diameter of eye	9·5	6·0	7·0	6·0	8·0	10·0
Length of snout	21·6	9·0	10·8	10·4	18·6	25·0
Interorbital width	18·5	8·0	8·8	8·2	14·0	21·0
Depth of body	43·5	20·3	26·8	23·3	37·5	48·0
Longest ray of dorsal	38·0	20·2	23·0	27·2	32·0	42·5
Longest ray of anal	34·0	15·1	18·3	20·3	27·2	40·0
Length of pectoral	38·2	16·6	18·8	19·2	29·0	39·2
Distance between pectoral and base of ventral.	25·5	11·6	13·3	14·0	23·0	31·3
Length of ventral	35·5	15·7	17·2	20·0	26·2	37·0
Distance between ventral and base of anal.	17·0	7·3	10·5	8·0	21·2	26·5
Length of caudal peduncle	41·0	15·7	19·0	18·7	31·0	52·0
Least height of caudal peduncle	23·5	9·0	11·0	11·0	17·0	21·0

Oreinus sinuatus var. **griffithii** McClelland.

1842. *Oreinus Griffithii*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 581.
1842. *Oreinus maculatus*, McClelland, *ibid.*, p. 580.
1868. *Oreinus griffithii*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 160 (foot-note).
1868. *Oreinus sinuatus*, Günther (in part), *ibid.*, p. 161.
1933. *Oreinus sinuatus* var. *griffithii*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 700.
1934. *Oreinus sinuatus* var. *griffithii*, Hora, *ibid.*, XXXVII (in press).

In his account of the fish of Afghanistan in Griffith's collection, McClelland recorded specimens of the genus *Oreinus* from the head of the Ali Musjid stream (Khyber Pass), Kabul River, Gandamak, Pashat and Girdun Dewar. The examples from the Helmand River (Girdun Dewar) were referred by him to *O. plagiostomus* Heck., while those collected at Pashat (Kunar River) were described as *O. griffithii.* The young specimens obtained in the Kabul River, Ali Musjid stream and at Gandamak were designated *O. maculatus*, a species described by McClelland from the Simla Hills. From Günther's *Catalogue* it appears that no specimen of *O. griffithii* passed into the collection of the British Museum and consequently Günther could not define its exact specific limits as the description is meagre and defective. The species was, therefore, referred to in a foot-note as a doubtful form. *O. plagiostomus* was characterized by Günther on Afghanistan specimens (1 stuffed adult from Jallalabad and skins of one adult and one half-grown from Helmand River), while McClelland's young specimens of *O. maculatus*

from Gandamak were referred by Günther to *O. sinuatus*. Day in the *Fishes of India* (pp. 529-531) followed Günther's views, but in referring to *O. griffithii* under the description of *O. plagiostomus* made the following remark: *O. griffithii* "is said to differ but little from the above, its intestine are six times the length of the body, its *habitat* is Afghanistan, Koonur river, Pushut". It would thus appear that since the publication of the description of *O. griffithii* McClelland, it has not been possible for later workers to elucidate its exact systematic position. This was due to the fact that so far no specimens of the species were available for examination.

Dr. Chopra obtained a large series of specimens of a species of *Oreinus* in the Chitral Valley and though it differs but little from *O. sinuatus*, there are features which, in the present state of our knowledge of the genus, warrant separation of the two forms. Fortunately specimens have also become available from the Paghman River and Sir-i-Chashma (Kabul River) for comparison and these have made it clear that the Chitral *Oreinus* is also found extensively in the Kabul River and its tributaries in Afghanistan. It may be mentioned that Kunar River (or Chitral River), the type-locality of *O. griffithii*, is the principal river of the Chitral Valley whence Dr. Chopra obtained abundant material of the species.

Oreinus griffithii was briefly characterized by McClelland as follows: "The breadth of the mouth is equal to half the length of head, and of the interval from the extremity of the snout to the commencement of the pectorals. Dorsal spine large, vertical scales at the anal obsolete, posterior margin of the operculum round, snout smooth.

D. $\frac{4}{8}$: P. 20 : V. 11 : A. $\frac{1}{6}$: C. 19.

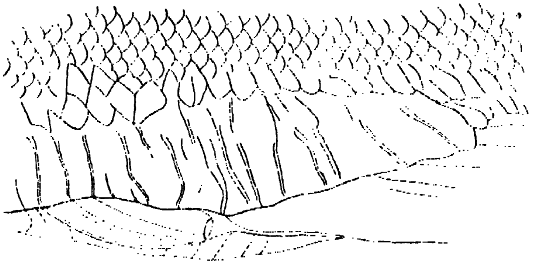
The intestines are six length of the body, and contain a brownish pulp. (Griffith.)

This species although perfectly distinct, differs but little in appearance from Oreinus plagiostomus.

Habitat.—Afghanistan, Koonur river, Pushut. (Griffith.)"

The reference to *O. plagiostomus* in the above description seems to have been partly responsible for our ignorance of *O. griffithii*. According to McClelland, the breadth of the mouth of *O. plagiostomus* "is equal to a third of the length of the head, and of the interval from the extremity of the snout to the pectoral fins"; the dorsal spine is "slender and soft" and the "vertical scales at the base of the anal are rather large". Günther's and Day's descriptions of *O. sinuatus*, to which *O. griffithii* is closely allied, and of *O. plagiostomus* show that the main differences between the two species lie in the character of the dorsal spine and the size of the anal scales. In the Schizothoracinae these characters are of great diagnostic value and are usually employed in distinguishing genera. Judging by these features, most of the specimens in Dr. Chopra's collection agree with *O. sinuatus* but there are two specimens, one 260 mm. long without the caudal from Pallarga stream in the Rambhur Valley and

the other 325 mm. long without the caudal from the Mastuj River between Koghazi and Mastuj, in which the anal scales are well developed and are as large as or larger than the diameter of the eye. The dorsal spine is of the nature so characteristic of *O. sinuatus*, and in other respects also they correspond with the remaining specimens. It is not possible to account for this variation as there are no gradations in the large series before me, and in the present state of our knowledge it would be better to consider them as abnormalities.



TEXT-FIG. 4.—Enlarged anal scales of a specimen of *Oreinus sinuatus* var. *griffithii* McClelland from the Pallarga stream. ×2. The scales are very thin and their outlines are not well defined.

It has been indicated above that *O. griffithii* very closely resembles *O. sinuatus* in its general facies, but differs in having somewhat finer serrations on the dorsal spine, in the shorter length of the spine and in the fact that all the fins, especially the anal, are shorter. The vertical anal scales are obsolete in *O. griffithii*, with the exception of the two specimens noted above, whereas in *O. sinuatus* the scales, though small, are fairly well marked and distinct. In view of these differences it seems desirable to treat *O. griffithii* as a distinct form, for the time being at least, and at the same time to express its close affinity to *O. sinuatus*. For these reasons, I have regarded *griffithii* as a variety of *sinuatus*.

There can be hardly any doubt that *Oreinus* is a specialized form of *Schizothorax* and that the evolutionary steps by which this modification has been brought about are not very difficult to comprehend. In fact, it is very difficult to distinguish the young of *Oreinus*, at least in the earlier stages, from those of *Schizothorax*. This difficulty is further augmented by a hybridization between *Schizothorax* and *Oreinus* which, as Dr. Chopra's collection shows, is a very common occurrence in nature and results in the production of forms intermediate between *Schizothorax* and *Oreinus*. I refer to this phenomenon later (*vide infra* p. 307). In the light of the above observations, McClelland's remarks regarding *O. maculatus* that "it is an intermediate form between Schizothorax and Orienus" is readily understood. According to McClelland, *O. maculatus* "seldom exceeds six inches in length" and is, therefore, a young form. There are several young specimens of *O. griffithii* in Dr. Chopra's collection which agree with *O. maculatus*, both in general

features and colouration. I have no doubt, therefore, that *O. maculatus* is a synonym of *O. sinuatus* and that both Günther and Day were justified in this conclusion.

The Kabul River form, *O. sinuatus* var. *griffithii*, may be redescribed as follows:—

D. 3/8; A. 3/5; P. 21; V. 10; C. 20.

Oreinus sinuatus var. *griffithii* is a strong and muscular fish in which the body is subcylindrical and both the profiles are somewhat arched. The ventral surface of the head and the anterior part of the body are flattish. The head is short and bluntly pointed; its length is contained 4·1–5·0 times in the total length without the caudal. In the young specimens, the head is proportionately larger, but during growth the other parts of the body develope more vigorously so that in larger examples it is about one-fifth of the length without the caudal. The head is almost as broad as deep at the occiput; the width of the head is equal to its length behind the anterior nostrils. The snout is usually smooth but in a number of half-grown and adult specimens it is covered with warts. These structures seem to characterize male specimens. The eyes are, for the most part, in the anterior half of the head; they are lateral in position but their upper margin is slightly below the dorsal profile of the head and they are not visible from the ventral surface. The eyes are proportionately larger in young specimens; their diameter is contained 4·1–6·7 times in the length of the head; 1·3—2·5 times in the length of the snout and 1·3—2 times in the interorbital width. The interorbital space is broad and flat. The mouth is inferior, transverse and slightly arched; the width of the mouth is somewhat greater than half the width of the head. The lips are fleshy and continuous; the upper lip covers the jaw and is simple, the lower lip is reflected from the jaw and is papillated. The exposed portion of the lower jaw is sharp and enclosed in a thick horny sheath. There are two pairs of small barbels. The gill-openings are moderate and extend to the ventral surface for a considerable distance.

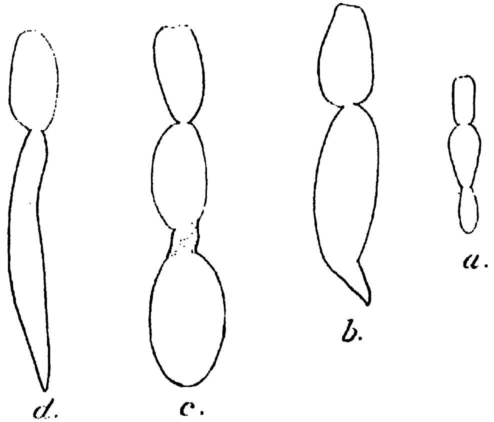
The depth of the body is contained 4·7—5·3 times in the length without the caudal; it is covered with small scales, about 110 along the lateral line and 28 between it and the base of the dorsal spine. The lepidosis is irregular. The tiled row of anal scales is indistinct, the largest scale being much less than half the diameter of the eye. The lateral line is slightly curved but it runs to the middle of the base of the caudal fin.

The dorsal fin commences in advance of the ventral and is nearer to the tip of the snout than to the base of the caudal fin; the dorsal spine is long and strong and is serrated with moderate spines posteriorly; it is not as long as the head and possesses a thin, flexible portion which is equal to the diameter of the eye. The posterior margin of the dorsal fin is slightly emarginate. The paired fins are horizontally placed and their outer rays are the longest. The pectoral fin is shorter than the head and is separated from the ventral by a considerable distance.

The ventral fin is considerably removed from the anal. The anal opening is situated just in front of the anal fin, which, when laid flat, is separated from the caudal fin by a considerable distance. The caudal fin is deeply emarginate; the lower lobe is better developed than the upper. The caudal peduncle is strong and muscular; its least height is contained 1·6–1·9 times in its length.

In young specimens the upper part of the body is marked with short, black streaks characteristic of *Oreinus maculatus*. The ground colour is grayish above and pale white below. In half-grown and adult specimens, the black markings disappear and the fish takes on a silvery hue. On this account it is usually known as "snow-trout".

Air-bladder. When dissecting specimens to examine the stomach contents, I found a great range of variation in the structure and form of the air-bladder in *O. sinuatus* var. *griffithii*. As the air-bladder is a character of great diagnostic value in the taxonomy of Cyprinoid fishes, it is necessary to make a few observations on the condition of the organ in the specimens before me.



TEXT-FIG. 5.—Air-bladders of 4 specimens of *Oreinus sinuatus* var. *griffithii* McClelland showing variation in form and structure. × ⅝. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

a. Three-chambered bladder of a young specimen 110 mm. long.
b. Air-bladder of a specimen 225 mm. long showing modification of the posterior chamber at the hinder end.
c. Three-chambered bladder of a specimen 265 mm. long. Notice the broad collar separating second and third chambers.
d. Normal type of air-bladder in an adult specimen. Notice the posterior chamber is narrow, elongated and thick walled and has not the form and structure of the normal bladder of the Cyprinoid fishes.

In a young specimen about 110 mm. long, the air-bladder is almost tripartite; the anteriormost chamber possesses somewhat thick walls,

the middle chamber is moderately thick-walled while the small, third chamber is thin-walled. The pneumatic duct opens between chambers one and two. At the constriction between the middle and the last chamber, the skin is specially thick. This tripartite condition is better marked in the bladder of another specimen (fig. 5 *c.*) about 265 mm. in length. Here instead of a constriction between chambers two and three, there is a definite collar of very thick skin while the last chamber is very thin walled. Normally in these fishes the air-bladder is bipartite, as is characteristic of the Cyprinidae. Owing to life in rapid waters and in consequence of a ground habit, the air-bladder is not much used as a hydrostatic organ and its walls become thick and inelastic (fig. 5*a*). The lumen decreases and the bladder becomes greatly reduced in size. It has been shown in the case of other genera[1] that the reduction and solidification of the bladder starts with the posterior chamber. In *griffithii* also probably the same process takes place. In a specimen 225 mm. in length, the end portion of the posterior chamber of the bladder was found to be thin and pointed and had very thick walls (fig. 5 *b*). Evidently the solidification of posterior chamber had started in this specimen at the right place and in course of time the bladder would have assumed the normal form as shown in figure 5*d*. The tripartite condition of the bladder in this species is certainly abnormal and, in my opinion, is produced by the thickening of the skin of the middle part of the posterior chamber instead of its hindermost part. In any case such a condition is not of any great importance for taxonomic purposes. I have shown elsewhere[2] that the bladder of hill-stream fishes is greatly reduced as they invade swifter and swifter currents and that if they happen to revert to deeper waters, a structure similar to the original bladder makes its appearance for hydrostatic purposes. Thus there is a close correlation between the structure of the bladder and the habitat of the fish. In fishes that live in rapid, but relatively deeper waters, the structure of the bladder must be very variable as has been shown above in the case of *Oreinus*.

Tchang,[3] in establishing his genus *Parosteobrama* has observed that " vessie natatoire en 3 parties, la premiere, ovale et arrondie aux deux bouts, la deuxieme plus longue que la premiere, la troisieme tres petite ". Unfortunately no figure is published but the description indicates a structure similar to the one figured here as 5*b*. It is probable that the so-called third chamber of *Parosteobrama* represents the area where the bladder has started to acquire thick walls. It should also be borne in mind that *Rohtee* (=*Parosteobrama*) is a genus of clear-water streams and though it is not found in very swift currents, it is always subject to sudden rush of waters. Such a habitat also denotes a varying environment. Mukerji[4] has shown that normally there are only two chambers in *Rohtee*. In *R. pelligrini* the third chamber may be only a modified portion of the second as stated above.

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[1] Hora, *Journ. As. Soc. Bengal* (N. S.) XVIII, pp. 5-7 (1922).
[2] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 374-385 (1930).
[3] Tchang, *Bull Soc. Zool. France* LV, pp. 46-52 (1930).
[4] Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 69 (1934).

Distribution and Habitat.—*Oreinus sinuatus* var. *griffithii* has so far been recorded from the Kabul River and its tributary streams. It was originally described from the Kunar or Chitral River. The species is well represented in the Chitral Valley whence Dr. Chopra collected specimens from the following localities:—

(i) 38 specimens from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).

(ii) 21 specimens from the Bumboret River between Daimali and Karakal in the Bumboret Valley (Sta. 7).

(iii) 86 specimens from the Lutkuh River near Uts or Hot Springs (Sta. 9).

(iv) 14 specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).

(v) 22 young specimens from a small stream near Surguz (Sta. 13).

(vi) 11 specimens from a small stream between Tar and Drosh (Sta. 15).

(vii) 12 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).

(viii) 28 specimens collected at Chitral in August 1929.

The larger specimens were obtained from rivers with rocky beds and fast currents, while the young ones were collected from small streams generally containing vegetation or with a sandy bed. It seems probable that the small streams form the nurseries where larger fish resort to for breeding purposes. Most of the young specimens appear to be intermediate between *Schizothorax* and *Oreinus*, and it seems likely that some of them are hybrids. I have discussed the affinities of such specimens below. According to Dr. Chopra's observations the species lives under stones and rocks.

Bionomics.—The alimentary canal of *O. griffithii* is greatly convoluted and is about 2·6 times the total length of the fish. As has already been observed by Griffith, it contains a brownish pulp, but in one case both the stomach and the intestine were full of sand and gravel. The structure of the lips and jaws shows that the fish adheres to smooth rocks and scrapes off algal matter which, no doubt, forms its principal food. Its horizontal paired fins, flattish ventral surface and the papillated lower lip are modified for the purpose of adhesion; whereas its subcylindrical body is adapted to offer the least resistance to rushing currents. During floods in the Bumboret River, a few specimens of *griffithii* were washed ashore; but the mortality among this species was not so high as in *Glyptosternum reticulatum*. *Oreinus* is a powerful swimmer and can dart from rock to rock with great rapidity. It prefers to live among rocks on the sloping side of a rapid over which water rushes with great speed.

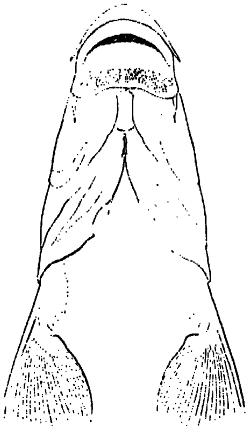
Local Name.—According to Dr. Chopra, *O. sinuatus* var. *griffithii* is known as *Omatchhi* among the Kafirs.

Measurements in millimetres.

	Specimens with enlarged anal scales.							
	Sta. 2.	Sta. 12	Sta. 2.		Sta. 12.		Sta. 9.	
Total length excluding caudal	325·0	260·0	168·0	102·0	122·0	103·0	265·0	255·0
Length of head	64·0	52·0	38·0	22·0	27·0	25·0	52·0	52·0
Width of head	43·0	33·0	24·0	14·5	17·0	14·0	36·0	35·0
Height of head	43·0	33·0	24·0	14·5	19·0	16·5	34·0	34·0
Diameter of eye	10·0	8·0	7·0	4·5	6·0	6·0	9·0	9·0
Length of snout	25·0	18·0	14·0	9·0	9·0	8·0	20·0	17·0
Interorbital width	20·0	16·0	10·0	6·0	9·0	8·0	16·0	15·0
Depth of body	66·0	49·0	33·0	20·0	25·0	22·0	55·0	53·0
Length of dorsal spine	45·0	41·0	29·0	18·0	22·0	22·0	42·0	38·0
Longest ray of anal	60·0	39·0	27·0	15·0	21·0	19·0	43·0	38·0
Length of pectoral	64·0	43·0	32·0	19·0	21·0	20·0	45·0	43·0
Distance between pectoral and base of ventral.	35·0	30·0	12·0	9·5	10·0	8·0	25·0	26·0
Length of ventral	58·0	40·0	28·0	17·0	20·0	19·0	41·0	39·0
Distance between ventral and anal	30·0	24·0	9·0	6·0	6·0	6·0	16·0	18·0
Length of caudal peduncle	60·0	42·0	22·0	13·0	16·0	14·0	46·0	42·0
Least height of caudal peduncle	35·0	30·0	17·0	10·0	13·0	10·0	32·0	30·0

? Schizothorax labiatus × Oreinus sinuatus var. griffithii.

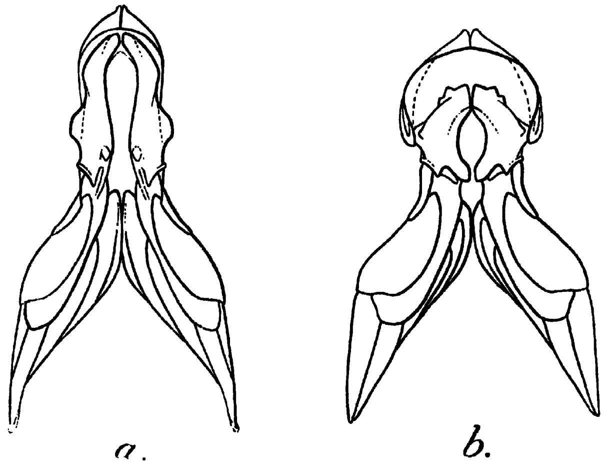
References have already been made (*vide supra*, pp. 294, 302) to the fact that in Dr. Chopra's collection there are several young and half-grown specimens in which the structure of the lips and jaws is interme-



TEXT-FIG. 6.—Ventral surface of head and anterior part of body of *Oreinus sinuatus* var. *griffithii* McClelland showing the nature of lips and jaws.

diate between *Schizothorax* and *Oreinus*. In fact, all possible gradations exist between the *Schizothorax* and the *Oreinus* types of mouth.

I have also no doubt that *Oreinus* is a more specialised form of *Schizothorax* and that it is better adapted to live in swifter currents. The modifications of the lips and jaws are clearly indicative of such a specialisation. The two genera are very closely related, the main difference being that in *Oreinus* the broad, short and flat mandibles are loosely joined together. The anterior margin of the lower jaw is exposed and is covered with a thick horny sheath. The lower lip forms a papillated, broad band behind the naked portion of the jaw and is probably used for adhesion. In conformity with the bony structures mentioned above the head is short, flat and depressed in *Oreinus*, while it is elongated and narrow in *Schizothorax*.



TEXT-FIG. 7.—Skeleton of the lower jaw and associated structures of *Schizothorax* and *Oreinus* in ventral view. × 1½.

a. Schizothorax labiatus (McClelland).
b. Oreinus sinuatus var. *griffithii* McClelland.

A few selected stages between the *Schizothorax* and the *Oreinus* types of mouth-parts may be described here.

(*a*) Total length 148 mm. Length of head 34 mm.

The central lobe of the lower lip is much narrower otherwise it is similar to that of *Schizothorax labiatus*.

(*b*) Total length 131 mm. Length of head 31 mm.

The structure of the lips and the associated parts is not very different from that of the typical examples of *Schizothorax labiatus*.

(*c*) Total length 141 mm. Length of head 31 mm.

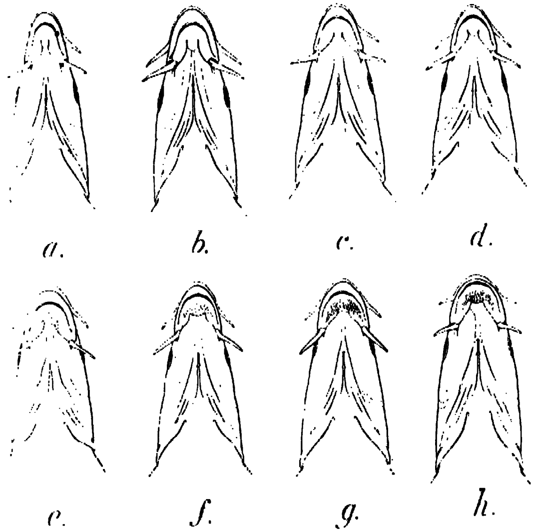
The mandible has become somewhat shorter and broader and the central lobe of the posterior lip is slightly reduced.

(*d*) Total length 153 mm. Length of head 34 mm.

The posterior lip is still further modified and the snout is considerably broad.

(*e*) Total length 137 mm. Length of head 30 mm.

The head has assumed the *Oreinus* form though the structure of the lips and jaws is not of the *Oreinus* type yet. The central lobe of the posterior lip has disappeared and its middle part has become papillated. The barbels are somewhat shorter.



TEXT-FIG. 8.—Ventral surface of head in eight specimens intermediate between *Schizothorax* and *Oreinus* in regard to the nature of the lips and jaws and the form of the head. All figures are more or less of natural size.

a-d represent retrogressive modifications in the *Schizothorax labiatus* type of mouth-parts, while e-h represent progressive modifications towards the formation of an *Oreinus* type of mouth-parts.

(*f*) Total length 128 mm. Length of head 30 mm.

The head is more or less of the *Schizothorax* type but the lips are considerably modified. The posterior lip is papillated.

(*g*) Total length 145 mm. Length of head 34 mm.

The head is not so broad as in *Oreinus* but the extent of papillae on the lower lip is considerably greater.

(*h*) Total length 141 mm. Length of head 32 mm.

The head is of the *Oreinus* type and the posterior lip is papillated. The most remarkable feature of this specimen is that the mouth is situated only slightly behind the tip of the snout.

It is clear from the measurements given above that the various modifications are not correlated with size.

When determining the collection from Chitral these intermediate forms proved very troublesome, for it was noticed that in the normal young of *Oreinus* the characters of the genus were present in earlier stages of development and they could readily be referred to *O. sinuatus* var. *griffithii*. Similarly the lip character of *Schizothorax labiatus* is also marked at an early stage. After a great deal of consideration I can suggest two possibilities for the occurrence of these intermediate forms. They are either the young of *Oreinus* which have not shaken off the ancestral characters of *Schizothorax* or they represent hybrids between the two common 'Barbels' of the Chitral Valley. The latter supposition seems to be more justified, for intermediate forms occur in great abundance. Even Griffith and McClelland noticed their presence in Afghanistan. Hybridisation among fishes in nature is not a rare occurrence, and several instances have been figured and described by Berg from Central Asia. Both *Oreinus* and *Schizothorax* live in large, rapid-water rivers and prefer a more or less similar habitat—the rocks of the rapids in the course of streams. If the breeding period of the two Chitral species were to coincide at any place, there is a liklihood of the production of a large number of hybrids. The examination of the gonads of the two species shows that they both breed in the summer months and it is not unlikely, therefore, that the intermediate forms in Dr. Chopra's collection represent hybrids between *Schizothorax labiatus* and *Oreinus sinuatus* var. *griffithii*.

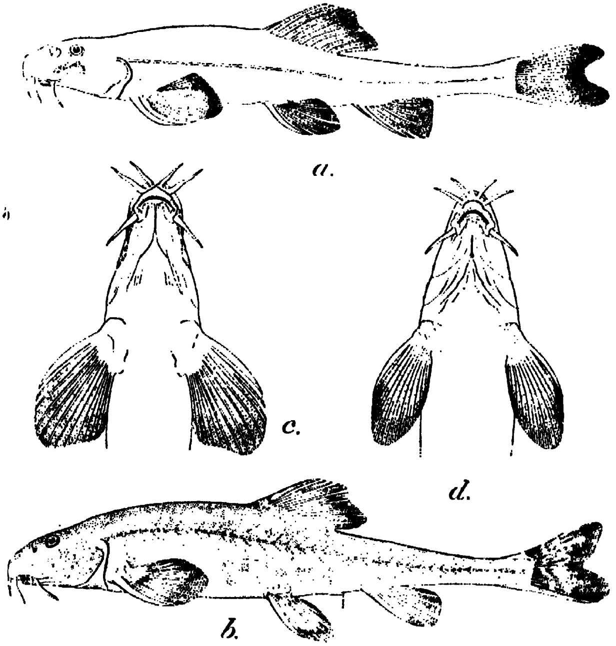
Nemachilus choprai, sp. nov.

D. 3/8; A. 2/5; P. 11-12; V. 8.

Nemachilus choprai is a large and stoutly built species in which the body tapers towards both ends, but very markedly towards the tail. The dorsal profile is gently arched, but the ventral surface is flat and horizontal and the ventral profile is almost straight up to the anal-opening. The caudal peduncle is long and narrow and whip-like. The body is naked, smooth and glossy. The paired fins are horizontally placed.

The head is depressed and flattened on the ventral surface; it is evenly pointed in the female specimens whereas in the males the snout is broader and the extremity is much more rounded. The length of the head is contained 4·7—5·1 times in the total length without the caudal and 5·6—5·9 times in the length with the caudal. The width of the head is contained 1·4—1·6 times and its height at the occiput 1·6—1·9 times in its length. The depth of the body varies considerably with the sex of the individuals; in some ripe females it is contained 5 times in the length without the caudal. Usually the depth is contained 5·9—9 times in the length with the caudal and 5—7·6 times in the length without the caudal. The eye is situated either entirely or for a greater part of its length in the posterior half of the head; it is placed dorso-laterally and is not visible from the ventral surface. The diameter of the eye is contained 6·1—7·4 times in the length of the head, 2·9—3·5 times in the length of the snout and 1·5 to 2 times in the interobital distance. The nostrils are situated nearer to the eyes than to the tip of the snout; there is a well marked flap between the

two nostrils on each side. There are six well-developed barbels, 4 rostral and two maxillary; all are much longer than the diameter of the eye. The small, lunate mouth is situated on the ventral surface considerably behind the tip of the snout; it is bordered by prominent fleshy lips which are continuous at the angles of the mouth. The lower lip is interrupted in the middle where the lower jaw is left uncovered. When the mouth is closed, the upper jaw, which is sharp and vertical, lies in front of the lower jaw. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow; its least height is contained 4·5—5·2 times in its length in the females and 5—5·9 times in the males.



TEXT-FIG. 9.—*Nemachilus choprai*, sp. nov.

a. Outline drawing of the lateral view of a male specimen showing secondary sexual characters. $\times \frac{3}{5}$.
b. Lateral view of a female specimen. $\times \frac{3}{5}$.
c. Ventral surface of head and anterior part of body of a male specimen. $\times 1$.
d. Ventral surface of head and anterior part of body of a female specimen. $\times 1$.

The difference in the general facies and in the form of the head in the two sexes is very marked.

The dorsal fin begins in advance of the ventrals and its commencement is almost midway between the tip of the snout and the base of the caudal; in some individuals it is somewhat nearer to the former than to

the latter. The longest ray of the dorsal is shorter than the depth of the body in ripe females; whereas it is invariably longer in the males. The upper margin of the fin is notched and its anterior upper corner is rounded. The pectoral fin is shorter than the head and is provided with a muscular base; it is rounded, horizontally placed and provided with a number of broad, bony rays anteriorly. The pectoral fin extends for about three-fifths of the distance between the bases of the pectoral and ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin though considerably shorter; it just reaches or extends beyond the anal opening, which is followed by a deep groove. The males are provided with a well-marked papilla in this groove and in them the ventrals almost reach the base of the anal fin. There is a fleshy appendage at the base of the ventral which is adnate to the body throughout its length. The anal fin is short and its posterior margin is rounded; it is separated from the caudal fin by a considerable distance. The caudal fin is shorter than the head and is deeply emarginate with the lobes rounded. In some examples the upper lobe is slightly longer than the lower.

The colouration of this species seems to be fairly constant. The ground colour is pale-olivaceous with the ventral surface possessing a uniform lighter colour. The dorsal surface and the sides are clouded with a number of black patches which are more numerous and of a deeper colour above the lateral line. The ground colour appears in minute spots here and there. On the dorsal surface in the tail region there is a series of four to five broad, but short, bands of the ground colour. There are sometimes horizontal, narrow streaks of lighter colour in front of the dorsal fin. The pectoral, ventral and anal fins are without any markings. The caudal fin is irregularly marked with a number of bands, while there are indications of similar bands on the dorsal fin. The anterior margin of the undivided rays of the dorsal fin is conspicuously marked with about 5 dark spots. This last feature is characteristic of the species.

In young specimens, up to about 100 mm. in total length, the general colouration is relatively lighter and there is usually a series of rounded spots all along the lateral line.

Type-specimen :—F 11301/1, *Zoological Survey of India* (*Ind. Mus*).

Distribution and *Habitat* :—*Nemachilus choprai* is the only loach known from the Chitral Valley whence Dr. B. N. Chopra obtained as many as 131 specimens. They were collected in the following localities :-

(i) Forty-seven specimens from the Lutkuh River near Hot Springs (Sta. 9). (*Type-locality*).
(ii) Thirty-two specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).
(iii) Three specimens from a small stream above Charun in the Mastuj Valley (Sta. 14).
(iv) Forty-nine specimens from the Chitral River near the Chitral town.

Nemachilus choprai lives in large rivers with a swift current. The bed of such streams consists of stones and boulders with patches of sand and mud here and there. The water is usually clear but becomes muddy after freshets. Dr. Chopra did not observe any vegetation growing

in the large streams, but in the small stream above Charun there was plenty of vegetation and the bottom consisted of mud and sand with a few stones. The three relatively young specimens in the collection were obtained from this small stream, and it seems probable that the mature specimens migrate to smaller streams with plenty of vegetation for spawing purposes. In such situations the young not only get protection in vegetation, but they find a number of small organisms to feed on.

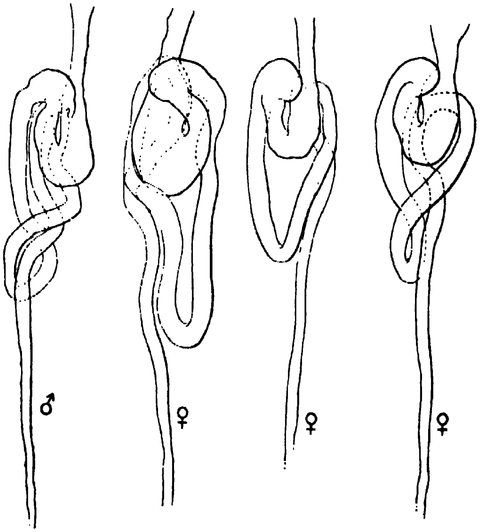
Sexual Dimorphism and *the Proportion of Sexes* :— *Nemachilus choprai* exhibits well-marked secondary sexual characters and the two sexes can be separated even in specimens about 100 mm. in total length though the species grows to about twice this size. The males are provided with the usual secondary sexual characters which consist of a raised tuberculate area below the nares, separated ventrally by a groove from the adjacent parts of the skin, of a second tuberculate area behind and below the first one and of broad pectoral rays which are provided with thickened tuberculate pads on their dorsal surface. Besides these obvious differences the males possess a broader and more rounded snout, a longer and narrower caudal peduncle and a papilla in the groove behind the anal opening. The males are usually of a larger size and in them the ventrals almost reach the anal fin.

Of the 131 specimens of *Nemachilus choprai*, there are 30 females and 101 males, or a proportion of 22·9 per cent. females and 77·1 per cent. males. If these calculations indicate an actual proportion of sexes in the population, the fact is remarkable. The preponderance of the males in the collection may be due to the fact that they are of much stronger build and are possibly of very active habits; whereas the females may be of secretive habits and thus liable to escape the notice of collectors. This alone, however, does not seem sufficient to account for the great difference in the percentage of the two sexes.

Bionomics.—*Nemachilus choprai* is a bottom dwelling fish. Its flattened ventral surface and broad, rounded and horizontal paired fins are no doubt used for grappling on to the smooth surfaces of rocks. The greatly reduced air-bladder also indicates that the fish lives mostly at the bottom, where it either crawls with the help of its paired fins, or darts from rock to rock with the help of its muscular tail and the whip-like caudal peduncle. Its long and narrow streamline form is adapted both for rapid movements as also for offering less resistance to swift-flowing currents. At the bottom the fish feeds on algae and slime that grow on rocks. Several kinds of Dipterous, Trichopterous and Ephemeropterous larvae that live on bare stones or among algae also form a substantial part of the food of this species. Large Coleopterous larvae that usually live among pebble at the bottom were also found in the stomach of *N. choprai.* The nature of food indicates a ground habit of life. The entire intestine is usually full of sand and gravel, most of which is probably derived from the cases of Trichopterous larvae and pupae.

The food is scraped from the rocks with the sharp and shovel-like posterior jaw while the anterior jaw, which lies in front of it and forms a vertical plate, helps to prevent the escape of the heterogenous scraped matter. The position, in which the coils of the alimentary canal lie,

varies considerably as shown in the accompanying figure. It appears that females feed most voraciously when the gonads begin to develop, but in specimens with fully developed ovaries the stomach is either empty or contains very little food. In such cases the liver is also greatly reduced. It seems probable, therefore, that about the spawning time the females give up feeding altogether. The ovaries fill up the body cavity to such an extent that feeding seems almost a physical impossibility. Most of the individuals opened had only insect larvae in their stomachs.



TEXT-FIG. 10.—Alimentary canal of *Nemachilus choprai*, sp. nov. ×1½.
The four drawings illustrate the variable nature of the coils of the alimentary canal.

Remarks.—*Nemachilus choprai* belongs to the Central Asiatic group of species in which the caudal peduncle is long and narrow. It is closely allied to *N. tenuis* Day and *N. kashmirensis* Hora. The former possesses a narrower head and longer barbels; while in the latter the caudal peduncle is 3—3·9 times its least height and the eyes are situated almost in the middle of the length of the head. The colouration of *N. choprai* is different from either.

Until quite recently very little was known regarding the Nemachili that inhabit the waters of Afghanistan. Griffith[1] had observed that a loach was very common in the small channels by which the springs at Sir-i-Chashma run off and through the kindness of Major A. E. Farwell

[1] McClelland, *Calcutta Journ. Nat. Hist.* II p. 564 (1842).

Measurements in millimetres.

	♀	♀	♀	♀	♀	♀	♀ (fig.)	♂	♂	♂ (fig.)	♂	♂
Total length including caudal	133·5	134·5	141·5	144·0	150·5	162·0	162·0	150·0	156·0	161·6	163·0	172·0
Length of caudal	20·0	21·0	21·0	21·0	22·0	22·0	25·5	25·0	22·0	23·8	25·0	27·7
Length of head	23·0	24·0	23·7	25·2	25·4	28·3	28·0	26·2	27·5	29·0	29·0	30·0
Width of head	15·7	16·3	16·5	16·7	16·3	20·0	19·2	17·2	17·4	19·0	20·0	18·0
Height of head	13·2	13·2	13·2	14·3	14·0	15·3	16·0	16·0	15·8	14·8	16·0	15·7
Depth of body	17·8	19·0	24·0	16·0	21·2	25·3	25·0	17·5	21·0	19·0	20·2	21·0
Length of snout	11·0	11·2	12·2	11·6	12·2	13·5	14·0	12·5	14·0	14·2	15·0	14·7
Diameter of eye	3·5	3·7	3·4	3·7	3·6	4·1	4·4	4·3	4·5	3·9	4·2	4·6
Interorbital width	5·6	5·8	6·0	6·5	7·0	7·5	8·0	7·0	7·2	7·8	6·3	8·0
Length of caudal peduncle	29·2	31·0	29·3	30·0	31·0	36·0	34·5	32·0	35·8	37·0	35·0	38·0
Least height of caudal peduncle	5·6	6·0	6·5	6·5	6·5	7·0	7·0	6·0	6·6	6·2	7·0	7·5
Longest ray of dorsal	18·7	17·5	18·2	18·6	20·1	21·8	21·0	18·5	21·0	20·6	22·0	26·0
Longest ray of anal	15·5	15·0	16·0	18·5	17·0	20·6	18·0	19·0	18·8	20·2	20·0	23·0
Length of pectoral	20·6	20·5	22·0	24·0	21·2	26·6	24·5	25·0	24·2	27·0	26·0	29·0
Length of ventral	18·0	17·0	19·6	20·0	19·5	21·0	21·5	20·5	20·7	22·0	21·0	24·2

four young specimens were obtained last year from this locality.[1] Similar specimens have also been collected from the Paghman River[2] and the Chahiltran stream, both tributaries of the Kabul River. This Kabul River form has been described by me as *Nemachilus griffithii* var. *afghana*. In this variety the caudal peduncle is not so long and whip-like as in *N. choprai*; the least height of the caudal peduncle being contained 2—2·2 times in its length. Besides these two forms, no other loach has so far been described from the upper reaches of the Kabul River and its tributary streams.

I (*op. cit.*, 1934) have recently remarked on the other species known from Afghanistan and it may be noted that *N. choprai* is abundantly distinct from all these forms. *Adiposia boutanensis* possesses an adipose dorsal and has a very characteristic facies, while *Nemachilus griffithii*, though very close to *N. choprai*, differs slightly in the length of the barbels, the position of the eye, the length of the pectoral, the colouration, etc., and has a different type of caudal peduncle. In the types of *N. griffithii* the least depth is contained 2·6—3 times in the length, whereas in *N. choprai* the figures are 4·5—5·9. When comparing the two forms, this character strikes one directly.

The measurements of a dozen specimens (7 ♀♀ and 5 ♂♂) collected in the Lutkuh River near Hot Springs are given on the opposite page.

Nemachilus kashmirensis Hora.

1876. *Nemacheilus rupicola*, Day (*nec* McClelland), *Proc. Zool. Soc. London*, p. 799.
1878. *Nemacheilus rupicola*, Day (*nec* McClelland), *Sci. Res. 2nd Yarkand Mission Ichthyology*, p. 17.
1922. *Nemachilus kashmirensis*, Hora, *Rec. Ind. Mus.* XXIV, p. 76.

In 1922, it was shown that Day had confused his Kashmir specimens of *Nemachilus* and had wrongly referred them to *N. rupicola* (McClelland), a species widely distributed in the Simla Hills. The name *kashmirensis* was proposed for this form and several specimens collected in the Verinag and Kukarnag Springs and in a small stream at Harwan were assigned to it. At the time I did not give a full description of the species and subsequently, owing to pressure of other work, it has not been possible to prepare a monograph on the Indian species of the genus in which I hoped to publish the description of the new species. *N. kashmirensis* is closely allied to the species described above and as Kashmir and Chitral are adjacent countries I have thought it advisable to publish the account of the Kashmir form here.

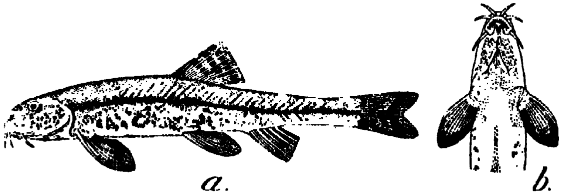
D. 3/8; A. 2/5; P. 12; V. 8.

In *Nemachilus kashmirensis* the body tapers towards both ends and the dorsal profile is gracefully arched. The ventral surface is broad and flattened, and the ventral profile is straight and horizontal except in the region of the caudal peduncle. The fish is strongly built and

[1] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXVII, (in press).
[2] Hora, *Journ. Bombay Nat. Soc.* XXXVI, pp. 697-699, pl. figs. 1 and 2 (1933).

possesses a whip-like, long and narrow caudal peduncle. The body is smooth and glossy and devoid of scales. The head is evenly pointed, but somewhat rounded towards the extremity.

The head is proportionately much longer in the young specimens; its length is contained 4—4·7 times in the total length without the caudal and 4·7—5·8 times in the length with the caudal. The width of the head is contained 1·3—1·5 times and its height at the occiput 1·6—1·8 times in its length. The depth of the body varies with age as well as with sex; it is contained 5·7—7·2 times in the total length without the caudal and 7—8·8 times in the length with the caudal. The eye is situated dorso-laterally in the middle of the head and is not visible from the ventral surface; its diameter is contained 5—6·5 times in the length of the head, 2—2·6 times in the length of the snout and 1·3—1·8 times in the interorbital width. The nostrils are situated nearer to the eye than to the tip of the snout. There are six barbels, two maxillary and four rostral; they are well marked and are longer than the diameter of the eye. The mouth is on the ventral surface behind the tip of the snout; it is bordered by well-developed lips, which are continuous at the angles of the mouth and are fimbriated. The lower lip is interrupted in the middle and each portion is reflected backwards. The ventral surface of the head is rugose and papillated. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow; its least height is contained 3—3·9 times in its length.



TEXT-FIG. 11.—*Nemachilus kashmirensis* Hora.
a. Lateral. view. $\times \frac{3}{4}$.
b. Ventral surface of head and anterior part of body. $\times \frac{3}{2}$.

The dorsal fin is situated in advance of the ventrals and its commencement is equidistant between the tip of the snout and the base of the caudal fin; its longest ray is greater than the depth of the body below it and its upper margin is oblique and truncate. The pectoral fin is somewhat shorter than the head and is rounded posteriorly; it is horizontally placed and possesses a strong muscular base; it extends almost two-thirds of the distance to the base of the ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin; it extends considerably beyond the anal opening and is provided with a fleshy appendage at its base. The appendage is adnate to the body throughout its length. The anal fin is short and is similar to the dorsal; it is separated from the base of the caudal fin by a considerable distance. The caudal fin is somewhat shorter than the head; it is emarginate

with the lobes rounded, the lower lobe being slightly longer than the upper.

N. kashmirensis exhibits sexual dimorphism, but the secondary sexual characters of the male are not so well marked as is the case in several species of the Highlands of Central Asia. The rays of the pectoral fins are broad and bony in the males of *N. kashmirensis*, but tuberculated thickenings are absent on their upper surface. There is a slit-like groove in front of the eye, but there is no tuberculated pad on the head.

The colouration seems to vary considerably with growth. In adult specimens there are broad, black bands on the dorsal surface of the body. They are more marked in the tail region where they extend to the sides also; but anteriorly they become lost in the general mottled colouration of the body. The body is of a dark colour just above and below the lateral line; the upper surface of head is grayish while the entire ventral surface is pale-olivaceous. The dorsal fin is marked with three rows of spots across it, while the caudal fin is provided with about three wavy bands. The ventral and the anal fins are also spotted sometime, while the dorsal surface of the pectoral fins is infuscated with black markings. In the young individuals, besides the saddle-shaped bands on the dorsal surface, there are series of blotches along the lateral line or just below it on both sides. The general surface of the body is irrorated with black dots. In some specimens the body is covered with a number of anastomosing markings which superficially impart a uniform dark colouration to the upper surface and sides of the fish.

Type-specimen :—F10122/1, *Zoological Survey of India* (*Ind. Mus.*).

Distribution :—*N. kashmirensis* has been collected in Kashmir from the following localities :—

(i) Eight specimens from a stream flowing from the waterwork reservoir to the trout-farm at Harwan (*Type-locality*).
(ii) Seven specimens from a stream flowing out of the Kukarnag Spring.
(iii) Several young and half-grown specimens from the Verinag Spring.

Remarks.—It has already been indicated that *N. kashmirensis* shows great similarity to species with long and narrow caudal peduncle, such as *N. tenuis*, *N. lhasae*, *N. yasinensis*, etc. The following combination of characters distinguishes it from the allied species :—

(i) The ventral fin extends considerably beyond the anal opening.
(ii) The commencement of dorsal is equidistant between tip of snout and base of caudal.
(iii) The lateral line is complete and well marked.
(iv) The eye is in the middle of the head.
(v) The pectoral fin is somewhat shorter than the head.
(vi) The least height of the caudal peduncle is considerably greater than the diameter of the eye.

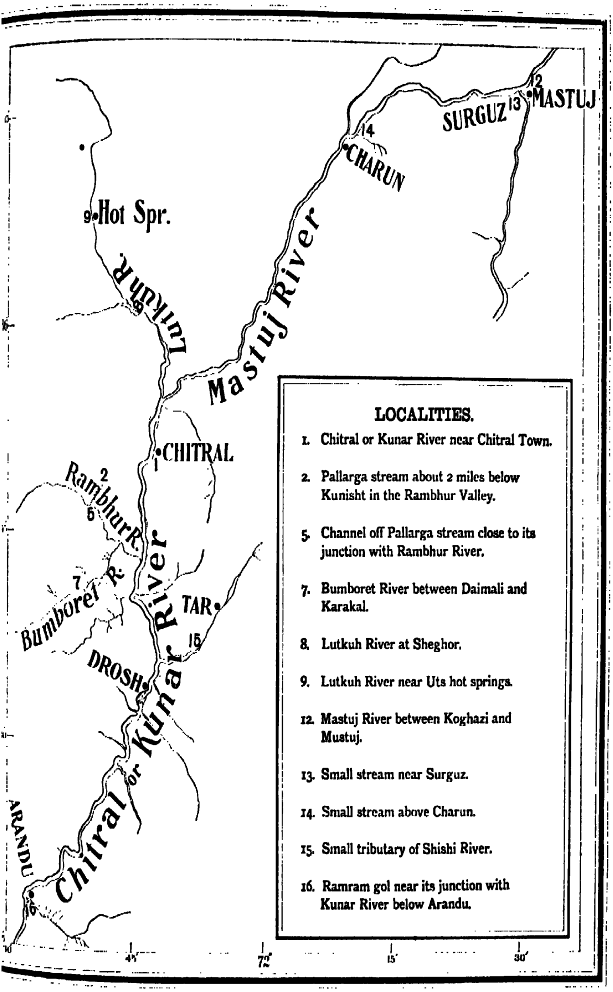
N. kashmirensis is further distinguished from all the related species by its general facies and the characteristic colouration.

Measurements in millimetres.

	Stream near trout-farm at Harwan.			Stream flowing out of Kukarnag Spring.		Vorinag Spring.	
Total length including caudal	98·5	92·4	77·4	93·8	62·4	55·0	41·2
Length of caudal	16·5	16·2	12·4	15·0	11·4	10·0	7·2
Length of head	17·6	16·0	13·7	17·0	12·2	11·0	8·6
Width of head	12·0	11·8	9·5	12·0	8·2	7·2	5·7
Height of head at occiput	10·0	9·8	7·3	10·6	7·1	6·2	4·8
Depth of body	12·2	13·3	9·0	12·3	8·3	6·2	4·8
Length of snout	7·9	7·7	5·3	7·8	5·6	4·9	3·4
Diameter of eye	3·2	3·0	2·1	3·1	2·4	2·0	1·7
Interorbital distance	4·9	5·0	3·9	4·8	3·2	2·8	2·6
Length of caudal peduncle	18·3	16·5	16·6	16·5	11·0	10·2	7·8
Least height of caudal peduncle	5·6	5·5	4·4	5·0	3·3	2·8	2·0
Longest ray of dorsal	12·8	13·0	11·0	13·0	9·5	9·5	6·2
Longest ray of anal	12·0	10·8	8·5	11·5	7·5	7·0	4·3
Length of pectoral	16·5	14·0	13·5	15·6	12·0	10·7	6·4
Length of ventral	13·2	12·4	10·8	13·5	9·0	8·5	4·6

EXPLANATION OF PLATE III.

A sketch map of the river system of the Chitral Valley, showing the principal localities in which fish were collected.



Sketch Map of the River System of Chitral Valley.

EXPLANATION OF PLATE IV.

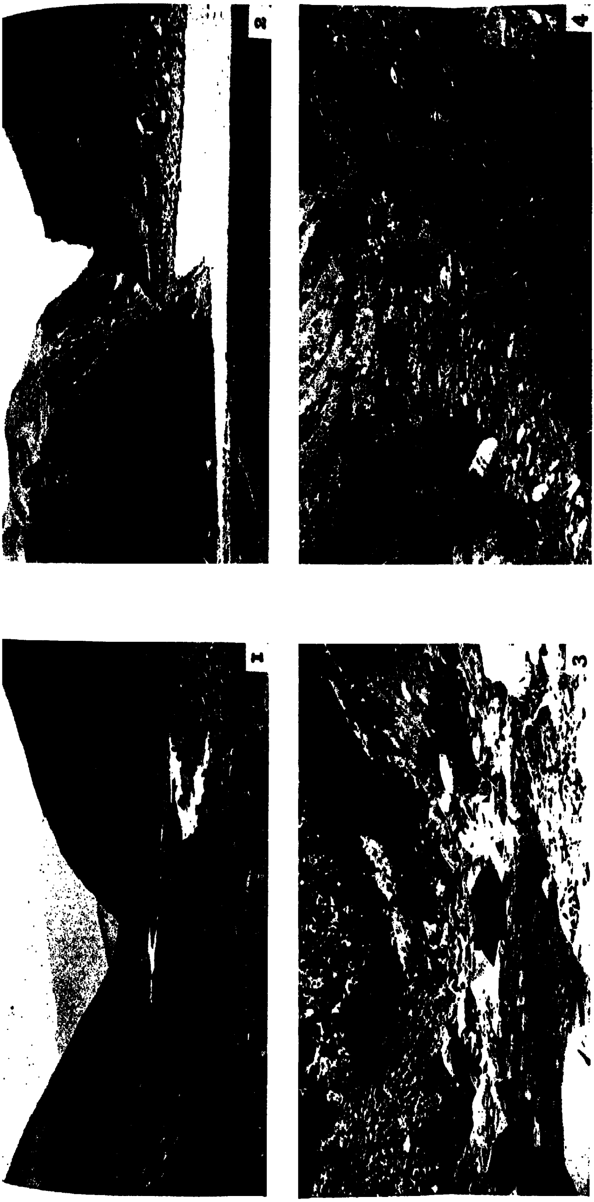
PHYSICAL FEATURES OF THE CHITRAL VALLEY.

FIG. 1.—The narrow and deep valley of the Lutkuh River.

FIG. 2.—Junction of the Lutkuh and the Mastuj Rivers to form the Chitral River. Notice the steep and bare hills.

FIG. 3.—A Red Kaffir basket used as a trap below a small waterfall to catch fish.

FIG. 4.—A small stream couple of miles above Rambhur, showing growth of vegetation on its sides.



B. Chopra, Photo.

Physical Features of the Chitral Valley.

FURTHER OBSERVATIONS ON THE BIONOMICS OF THE TADPOLES OF *RANA AFGHANA* GÜNTHER.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

In recent years considerable advance has been made (*vide* list of references) in our knowledge of the adaptive modifications undergone by the remarkable tadpoles of the section Ranae Formosae of the subgenus *Hylarana* of the genus *Rana*. These tadpoles possess an extensive suctorial disc by which they adhere very firmly to smooth rocks and boulders in the fiercest currents of the small torrential streams of south-eastern Asia. From time to time, I have made observations on the tadpoles of *Rana afghana* which are found in great abundance in suitable places in the Eastern Himalayas and in the hills of Assam. In the living condition, the animal has been studied hitherto from the dorsal surface, but during a recent visit—May-June 1934—to the Tista Valley below Darjeeling advantage was taken to study the mechanism of attachment by watching in a mirror the rôle of the different structures on the ventral surface of the animal. I have described elsewhere[1] the nature of the simple apparatus used for such a purpose. With the help of a mirror, it was possible to elucidate precisely the mode of progression and fixation of the tadpoles and to follow the course of the respiratory current with the help of carmine powder. Besides observations on these points, attention is directed to the nature of the food and to the probable feeding habits of the tadpoles.

Progression.

Crawling.—As has been indicated above, tadpoles of *Rana afghana* live on rocks in swift currents, and under these conditions they crawl about with the head always pointing upstream. A tadpole, quietly lying on the substratum, holds on to a rock both by means of its disc, including the posterior lip which forms the anterior border of the disc, and the broad anterior lip. As the tadpole begins to crawl, the animal appears to move forward with a series of short jerks, and corresponding with these movements the anterior lip seems to be relaxed and is thrust forwards in a continuous series of rapid waves. It has been assumed (5, p. 242) that during progression the anterior lip and the sucker perform the function of adhesion alternately, but recent observations have shown conclusively that the forward movement is initiated and carried on entirely by the broad anterior lip, while the sucker, which is firmly attached to the substratum throughout progression, follows in its wake with the forward movements. The sucker is pulled forward while still attached to the substratum, and in this process the vacuum inside it is not disturbed. In a normally active tadpole, under water, these

[1] Hora, S. L., Biological Notes on a Fish from Brazil in the Society's Aquarium. *Proc. Zool. Soc. London*, p. 205 (1932).

movements are too rapid to be analysed but the following device proved very helpful. A tadpole was placed in a wet dish and, by poking with a sharp point, it was made to crawl for some time. When the animal was sufficiently exhausted, the crawling movements became very slow, so that every action of the tadpole could be clearly observed and analysed.

During the forward movement, the mouth opened and closed in rapid succession in conformity with the jerking movements of the anterior lip. On account of the prominent black jaws, it was easy to observe these movements.

With the help of a pair of sharp scissors, the anterior lip was cut off, and it was observed that tadpoles treated in this way lost the power of crawling. They progressed slowly by slight jerks of the body which was detached from the substratum.

The above observations indicate that the anterior lip is the chief organ of progression, and that its power of fixation is so great that not only can it withstand the rush of water at the anterior end but can pull forward the entire body which is attached to the substratum by means of the sucker.

Occasionally tadpoles were observed to crawl backwards; but the mechanism by which this reverse movement was effected could not be elucidated. The anterior lip does seem to play some part in this process, but the reverse movement was so rare and of such a short duration that the actual mechanism could not be studied. It was noticed, however, that in the reverse movement the "steps" were somewhat longer than those in the forward movement, and that the distal part of the anterior lip trailed along at each "step."

The backward crawling movement of the tadpoles of *Rana afghana* is remarkable, especially when it is remembered that the teeth on both the lips and the spines on the tuberculated area along the posterior and lateral parts of the disc are directed backwards. All these sharp points are meant to prevent the slipping of the tadpole backward. It follows, therefore, that without the actual lifting of the organs of attachment from the substratum, any movement in the reverse direction would seem hardly possible. At all events only one of the two main organs of attachment could be disengaged with safety at a time. It seems probable that in the reverse movement the suctorial disc is disengaged first, moved backwards and fixed in a new position. The anterior lip is then disengaged and pulled backwards. By the repetitions of these movements, the tadpole is probably enabled to crawl in the backward direction.

Swimming.—Reference has already been made (5, p. 242) to the darting movement of these tadpoles. This movement is too rapid and its mechanism could not be studied with the naked eye. The body did not appear to be thrown into noticeable series of waves and the tail seemed to flap just a little. Probably the succession of muscular waves along the body was so quick that to the naked eye the body appeared to be held straight during progression.

In a dish containing water, the tadpoles were observed to swim occasionally, but the movements were very clumsy. Progression was effected by the undulating movements of the body and the head moved alternately from side to side. With an increase in the rate of progression,

the awkward slow movements of the animal became more and more graceful till in the darting movement the body appeared to be straight as mentioned above.

RESPIRATION.

In the tadpoles of *Rana afghana* the respiratory current enters through the nostrils though these structures are not in any way specially modified for this function. Reference may here be made to the nostrils of *Ascaphus truei* which according to Noble (**8**, p. 65, fig. 8), are specially modified for respiration in swift currents. In the tadpoles of *R. afghana*, the floor of the buccal cavity was noticed to rise and fall, and the passage of the respiratory current, which flows in from the nostrils, could also be inferred from the movements of the surface of the head in this region. When a cloud of carmine powder was floated over the head of the tadpole, it was sucked in through the nostrils but immediately "coughed" out through the mouth. The animal moved to another place at the same time. In tadpoles that had become languid through exertion the colouring matter was allowed to pass over the gills and was ultimately ejected through the spiracle. When clouds of carmine were floated along the lower margins of the head, no particle was taken in showing thereby that no current flowed below the head. When the anterior lip was damaged, the carmine powder was noticed to enter below the head but no definite current could be traced.

The tadpoles are capable of suspending respiration for short periods as is usual in the case of hill-stream fishes (**3**, p. 591).

The tadpoles frequently push their heads out of water by crawling along the sides of the dish in which they are kept, but they can stay in this position only for a short period. A tadpole kept in a wet dish desiccated and died within about an hour or so, showing thereby that the animal is not fully adapted for aerial respiration. When the head was out of water, the floor of the mouth showed no movement but a regular rise and fall of the area round the nostrils was observed.

It may be noted that the lungs of these tadpoles are small and thick-walled (**3**, p. 584; **6**, p. 382) and are apparently non-functional. In these circumstances aerial respiration can take place to a limited extent only through the skin of the animal.

FIXATION.

Sucker is the chief organ of fixation, but if its margin is in any way injured or damaged its efficiency is greatly impaired. The rows of backwardly directed teeth on the posterior lip and of spines on the tuberculated area prevent the sucker from slipping backwards in strong currents. It has been indicated above that in the natural habitat, the sucker is kept in action for almost the whole of the time, even during progression. The broad anterior lip, with its several rows of backwardly directed teeth, is also a powerful organ of adhesion. It may be pointed out here that the lips in conjuction with the mouth do not form a vacuum sucker. Normally the respiratory current does not flow in through the mouth and the

lips lie closely adpressed to the substratum, but there is no mechanism in this area that can produce a vacuum. The efficacy of adhesion in this region depends upon the strength of the anchoring devices, and on "seizing" which takes place when two surfaces are brought together in close contact. It has further to be noted that in the absence of a respiratory current flowing in through the mouth there is no area of low pressure in the region of the mouth, as is usually the case in a number of hill-stream fishes.

In the absence of any direct observations, it was presumed by me (**5**, p. 243) that the folds of the lips at the corners of the mouth form respiratory channels. In the case of *Rana afghana* tadpoles the respiratory current does not enter through the mouth (*vide supra*, p. 323), but it was observed that these folds serve a very important function during progression. When the anterior lip is thrust forward, the anterior jaw and the associated structures are also carried forwards along with it. At this time the folds open out so that the posterior lip which forms the anterior border of the sucker is not disturbed from its position. By this simple device, the action of the sucker is not impaired in any way. In the case of the tadpoles of *Ascaphus truei*, Noble has observed that "folds in sucker arranged to permit opening of the mouth (for locomotion) without seriously detracting from the suctorial nature of the apparatus" (**8**, p. 68). The lips of this animal do not form a sucker, but it seems probable that during progression the anterior lip moves in the same way as described above in the case of the tadpole of *R. afghana*, while the posterior lip is pulled forwards when still attached to the substratum. The folds of the lips permit the thrusting forward of the anterior lip without detracting from the adhesive properties of the posterior lip. It seems probable that wherever folds exist at the corners of the mouth in hill-stream tadpoles, they subserve the function as detailed above.

NATURE OF FOOD AND MODE OF FEEDING.

The alimentary canal of the tadpoles of *Rana afghana* consists of a long tube of almost uniform diameter throughout and possesses 3 or 4 coils. It is about five to six times as long as the distance between the tip of the snout and the anal opening. In its entire length, it is full of brownish, pulpy substance which, when examined under a binocular microscope, seems to consist of fine particles of sand and slime. No green filamentous algae were found inside the gut. It is probable, therefore, that the tadpoles feed on the slimy matter that is found encrusting apparently smooth rocks and stones even in very swift currents. The particles of sand no doubt get entangled in the slime as they drift down with the current. As is usual with the tadpoles of frogs, the slimy matter is probably rasped off the rocks with the help of the powerful jaws. No direct observations could, however, be made on the actual mode of feeding, but it seems probable that the anterior V-shaped jaw scrapes the food material and the broad posterior jaw prevents it from being washed away by the current. In any case it seems certain that in the tadpoles of *Rana afghana* the respiratory current does not serve as the food current of the animal.

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THREE NEW INDIAN SPECIES OF EUCNEMIDIDAE (COLEOPTERA)

By E. FLEUTIAUX, *Paris.*

Adelothyreus (Chevrolat) Bonvouloir, 1871-75.

Génotype : *A. flavosignatus* Bonvouloir.

Adelothyreus bengalensis, sp. nov.

♂ $4\frac{1}{2}$ à 5mm. Allongé ; noir opaque ; pubescence jaune plus apparente sur la moitié antérieure des élytres. Tête convexe, légèrement rugueuse ; épistome à peu près aussi large que l'espace susantennaire, sinué sur son bord antérieur ; carène interoculaire interrompue sur la base de l'épistome. Antennes dépassant les angles postérieurs du pronotum, noires fortement pectinées à partir de 3e article. Pronotum aussi long que large, parallèle, arrondi en avant, peu convexe sur le dos, déprimé de chaque côté à la base, brièvement sillonné au milieu sur l'éperon en face de l'écusson, avec deux bosses sur le dos, parfois vers la base, précédées chacune d'une fossette plus ou moins marquée ; surface rugueuse ; carène antérieure brusquement recourbée et prolongée en arrière jusque vers la moitié ; limite latérale entière ou presque, aboutissant au niveau du bord inférieur de l'oeil. Elytres légèrement plus étroits que le pronotum, déprimés transversalement à la base, parallèles, arrondis au sommet, convexes, rugueux, substriés. Dessous noir opaque ; pubescence jaune légère. Propectus fortement ponctué, métasternum un peu moins, abdomen plus légèrement. Propleures sans impression antennaire suturale, seulement un peu lisses le long de la suture prosternale. Episternes métathoraciques élargis en arrière. Hanches postérieures parallèles. Dernier arceau ventral en bec. Fémurs noirs ; tibias et tarses bruns. ♀ $4\frac{3}{4}$ à $5\frac{1}{2}$ mm. Plus robuste. Antennes serriformes à partir du 3e article.

Bengale : Samsingh, Kalimpong, 1800 pieds, dans les troncs pourris d'*Anthocephalus cadambii* et de *Macaranga denticulata*, janvier à avril (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Plus long que *A. africanus* Fleutiaux ; carène antérieure du pronotum plus prolongée en arrière, impressions antednaires des propleures tout à fait nulles.

Pendant longtemps l'on n'a connu que des espèces américaines ; ce n'est que tout récemment que deux formes africaines ont été décrites.

Arhipis BONVOULOIR, 1871-75.

Génotype : *Hylochares subacata* Guérin-Méneville.

Arhipis balwanti, sp. nov.

$3\frac{1}{4}$ à $4\frac{1}{4}$ mm. Oblong ; noir opaque ; pubescence courte, obscure, rare. Tête fortement ponctuée, sillonnée au milieu ; épistome à peu

près aussi large que l'espace susantennaire. Antennes noires, brunes vers le bout, moniliformes, ne dépassant pas la base du prothorax. Pronotum aussi long que large, parallèle, arrondi près des angles antérieurs, aplati sur le dos, très fortement et densément ponctué ; carène antérieure rejoignant la carène latérale. Élytres parallèles, arrondis à l'extrémité, convexes, très rugueusement ponctués, distinctement striés. Dessous de même couleur. Pattes brunes, fémurs plus foncés.

Bengale : Samsingh, Kalimpong, dans du bois d'essence inconnue, avril (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Distinct de *A. orientalis* Fleutiaux par sa forme plus courte, les élytres parallèles jusque près du bout, arrondis seulement à l'extrémité ; sa couleur noire ; la forte ponctuation rugueuse des élytres plus dense, les stries distinctes.

Melasis Olivier, 1790.

Génotype : *Elater buprestoides* Linné.

Melasis balwanti, sp. nov.

♂ 7 mm. ½. Allongé, cylindrique ; noir à peine brillant ; pubescence courte, obscure, peu apparente. Tête convexe, légèrement sillonnée au milieu en arrière, assez fortement et densément ponctuée ; épistome plat, court, large, peu rétréci en arrière ; bord antérieur bidenté ; base plus large que l'espace susantennaire. Antennes noires, ne dépassant pas la base du prothorax ; 2e article petit et étroit ; 3e deux fois plus long, triangulaire ; 4e fortement denté ; suivants pectinés : dernier simple et allongé. Pronotum aussi long que large, droit sur les côtés, élargi en avant ; convexe, sillonné au milieu en arrière, très brusquement déclive à la base ; très grossièrement ponctué, surtout sur les côtés, presque rugueux ; bord antérieur largement échancré en cercle : angles postérieurs arrondis ; postérieurs courts aigus. Elytres longs, cylindriques, conjointement arrondis au sommet, légèrement mais distinctement ponctués-striés ; interstries rugueux. Dessous de même couleur ; pubescence grise. Pattes comprimées ; fémurs et tibias bruns : tarses noirâtres, derniers articles pâles.

Bengale : Samsingh, Kalimpong, avril, sur *Gynocardia odorata* (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Plus étroit et plus parallèle que *M. buprestoides* Linné ; aspect plus brillant ; antennes plus longuement pectinées ; pronotum moins élargi en avant, sillonné au milieu seulement en arrière, notablement moins rugueux ; élytres plus parallèles, également moins rugueux ; pattes beaucoup moins épaisses et moins largement comprimées.

ON A COLLECTION OF INDIAN CEPHALOCHORDATES, WITH NOTES ON THE SPECIES FROM THE INDIAN WATERS IN THE INDIAN MUSEUM, CALCUTTA.

By B. PRASHAD, *D.Sc.*, *F.R.S.E.*, *F.A.S.B.*, *Director*, *Zoological Survey of India.*

Dr. F. H. Gravely, Superintendent, Government Museum, Madras, sometime back sent me a small collection of Cephalochordates for identification. The collection is not very large, but is of special interest in that some of the species represented in it have not been adequately described so far. The specimens are mainly from the collections made by "Lady Goschen"—the trawler of the Madras Fisheries Department, but there are also two tubes containing well-preserved material of the interesting species, *Branchiostoma indicum* (Willey) from Madras. In the following account I have also included short notes on the species from Indian waters in the Indian Museum collection.

The literature on the Indian Cephalochordates is not very extensive. The earliest account of a species of the genus *Branchiostoma* from the area is that of Gray[1], who described a species from Borneo under the name *Amphioxus belcheri*. Thurston recorded that the species had been dredged some 30 miles south of Madras in 1887-88[2]. Forster-Cooper[3] also recorded it from Madras, from off "Seven Pagoda, Mahabili" and according to Tattersall[4], who considered it to be a variety of *B. lanceolatum*, the species was collected from Singapore by Bedford and from Ceylon by Herdman.

Andrews[5] doubtfully recorded *B. lanceolatum* from Ceylon and Tattersall[6] after a careful review of the literature recorded the same species from various localities round the same Island. Franz[7], however, considered the specimens from round Ceylon to be distinct and described this form under the name *B. haeckelli.*

Willey[8] described an interesting species from the Black Pagoda, Orissa Coast, under the name *Dolichorhynchus indicus.* Tattersall considered the subgenus *Dolichorhynchus* superfluous and referred the species *indicum* to the genus *Branchiostoma*; he redescribed the species and recorded specimens of it from round Ceylon.

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[1] Gray, J. E., *Proc. Zool. Soc. London*, p. 35 (1847).
[2] Thurston, E., *Bull. Madras Govt. Mus.*, I, p. 26 (1980).
[3] Forster-Cooper, C., *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, I, p. 359 (1903).
[4] Tattersall, W. M., *Ceylon Pearl Oyster Rept.*, I, p. 212 (1903).
[5] Andrews, E. A., *Studies Biol. Lab. Johns Hopkins Univ.*, V, p. 238 (1893).
[6] Tattersall, W. M., *Op. cit.*, p. 210.
[7] Franz, V., *Jenais. Zeitschr. Naturwissen*, LVIII, p. 403, text-fig. 18 (1922).
[8] Willey, A., *Quart. Journ. Microsc. Sci.*, XLIV, pp. 269-71, figs. 1, 2 (1901). The author in this paper unfortunately uses the now name *Dolicorhynchus* both in a generic and subgeneric sense.

In addition to the neotenic form *Branchiostoma pelagicum* Günther, which was later separated by Goldschmidt[1] under the generic name *Amphioxides*, Tattersall[2] doubtfully referred a specimen from round Ceylon to Cooper's species, *B. californiense*. Franz[3], however, was of opinion that this record is probably to be referred to *B. elongatum* (Sundevall), of which the Ceylon form and the Cape species, *B. capense* (Gilchrist), are probably geographical varieties. In the Madras Museum collection, there are a number of specimens which agree with Tattersall's description, and as they differ from the true *B. elongatum*, I propose separating these under the name *B. gravelyi*.

Of the genus *Asymmetron* E. A. Andrews, *A. cultellus* (Peters), *A. cingalense* (Kirkaldy), *A. maldivense* (Forster Cooper), *A. agassizi* (Parker), *A. parvum* (Parker), *A. lucayum* Andrews and *A. orientale* (Parker) have been recorded from the Indian waters by various authors. For full literature regarding these species reference may be made to the works of Tattersall[4], Forster Cooper and Franz.

In reference to the nomenclature of the genera I have followed the masterly memoirs of Franz, and it is not necessary, therefore, to discuss the controversial questions of the genera and their nomenclature.

In the collections before me the following species are represented :--

1. *Branchiostoma belcheri* (Gray).
2. *Branchiostoma indicum* (Willey).
3. *Branchiostoma gravelyi*, sp. nov.
4. *Asymmetron cingalense* (Kirkaldy).

Genus **Branchiostoma** Costa.

Branchiostoma belcheri (Gray).

1847. *Amphioxus belcheri*, Gray, *Proc. Zool. Soc. London*, p. 35.
1889. *Branchiostoma belcheri*, Günther, "*Challenger*" *Reports*, XXXI, *Pelagic Fishes*, p. 43.
1890. *Branchiostoma belcheri*, Thurston, *Bull. Madras Govt. Mus.*, I, p. 26.
1895. *Branchiostoma* (*Amphioxus*) *belcheri*, Kirkaldy, *Quart. Journ. Microsc. Sci.*, XXXVII, p. 313, pl. xxxv, fig. 8.
1901. *Branchiostoma nakagawae*, Jordan & Snyder, *Proc., U. S. Nat. Mus.*, XXIII, p. 726.
1903. *Branchiostoma lanceolatum* var. *belcheri*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 299.
1903. *Branchiostoma lanceolatum* var. *belcheri*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 212, pl. i, fig. 3.
1913. *Branchiostoma belcheri*, Jordan, Tanaka & Snyder, *Journ. Coll. Sci. Tokyo.*, XXXIII, p. 4.
1922. *Branchiostoma belcheri*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 391, text-figs. 8-13.
1927. *Branchiostoma belcheri*, Franz, *Ergebn. Anat. Entwickelung.*, XXVII, p. 482.

B. belcheri originally described from Borneo is widely distributed in the Indo-Pacific. It has been recorded from the east coast of Africa,

[1] Goldschmidt, R., *Biol. Centralbl.*, XXV, pp. 235-40 (1905).
[2] Tattersall, W. M., *op. cit.*, p. 216.
[3] Franz, V., *op. cit.*, p. 406 ; see also Franz, V., *Ergebn. Anat. Entwickelung*, XXVII, p. 483 (1927).
[4] Tattersall, W. M., *Trans. Liverpool Biol. Soc.*, XVII, pp. 269-302 (1903).

Ceylon, Borneo, Philippines, the Prince of Wales Islands, Torres Straits, China and Japan.

Thurston remarked that the species had also been dredged earlier some 30 miles south of Madras, while Tattersall recorded it from Ceylon as a variety of *B. lanceolatum* (Pallas).

In the Madras Museum collection before me the species is represented by two series of specimens from :—

1. Tholayiram par, 10-16 fathoms, 28. iii. 28. 4 specimens.
2. Off Coilpatam, S. W. and W. of Tuticorin, 7-10 fathoms, 30. iii. 28—1. iv. 28.

The specimens are mostly immature and rather poorly preserved, but agree with the descriptions of Kirkaldy, Tattersall and Franz.

The largest specimen from off Coilapatam is 45 mm. and the youngest about 20 mm. long. In the larger specimens traces of gonads are to be seen, and in one specimen 27 and 25 on the right and left sides respectively were counted. The myotome formula is 37, 17, 10.

The Tholayiram par specimens vary from 30-35 mm. in length, and in one specimen 27 gonads on the right and 25 on the left side could be seen. The myotome formula is 37, 17, 9-10.

In the Indian Museum collection the species is represented by 11 specimens collected by the Surgeon Naturalist on the R. I. M. S. " Investigator " in the Mergui Archipelago, 16-20 fathoms. The largest specimen is 52 mm. long, and the myotome formula varies as 37-38, 17-18, 9-10. The gonads are developed in some specimens, but their exact numbers cannot be counted.

Branchiostoma indicum (Willey).

1901. *Dolichorhynchus indicus*, Willey, *Quart. Journ. Microsc. Sci.*, XLIV, p. 269, figs. 1, 2.
1903. *Branchiostoma indicum*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 300.
1903. *Branchiostoma indicum*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 215, pl. i, figs. 11-13.
1922. *Branchiostoma indicum*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 410.
1927. *Branchiostoma indicum*, Franz, *Ergebn. Anat. Entwickelung*, XXVII, p. 483.

Of *B. indicum* I have examined the 4 badly preserved types and a mounted slide in the collection of the Indian Museum and a large series of fresh specimens from off Madras kindly sent to me by Dr. R. Gopala Iyer of the Madras University. In addition I have also examined a few old specimens from Madras in the Indian Museum collection and two series of specimens marked " ? Madras " in the collection from the Madras Museum. In view of this extensive material I give below a few notes on the species and a good figure showing its main characters.

The specimens vary from white to pink or even brown in colour and the largest is 27 mm. long and about 3 mm. in maximum width. The

myotome formula (text-fig. 1) generally is 41, 14, 14, but in 3 specimens 42-43 preatrial and in 2 specimens 15 postanal myotomes were found. The myotomes in the anterior third of the animal are comparatively narrow as the main part of the body is occupied by the very broad pharynx.

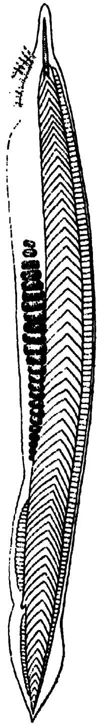

FIG. 1.—*Branchiostoma indicum* (Willey). Lateral view. ×6.

All the specimens show distinct preoral lobes, but their proportionate length agrees in general with Tattersall's figure rather than Willey's.

The rostrum is comparatively long, about as long as the first five myotomes, and appears as a somewhat narrow, tubular structure.

The dorsal fin is low and of an even height; it ends slightly in front of the first myotome anteriorly and slightly behind to the anus posteriorly.

The ventral fin has the usual fin chambers which also extend postanally. The caudal fin is relatively broad and almost pointed posteriorly; the infra-caudal lobe is slightly less deep than the supra-caudal, but is longer, extending very slightly beyond the anus.

The metapleural folds terminate symmetrically on either side of the ventral fin behind the V-shaped atripore (text-fig. 2).

The oral cirri are moderately long, about 40 in number, and are provided with distinct sense papillae.

The notochord extends into the long rostrum as a thin tube, but does not extend to the tip.

The neural tube projects slightly in front of the dorsal fin chambers, but stops short of the anterior termination of the dorsal fin.

There is no eye-spot.

The number of gonads varies from 25-27 on the right side to 22-24 on the left in both male and female specimens.

FIG. 2.—*Branchiostoma indicum* (Willey). Ventral view showing the symmetrical termination of the metapleural folds. ×6.

From the above description it is clear that all the specimens from off Madras are to be referred to Willey's species, *B. indicum*.

Branchiostoma gravelyi, sp. nov.

1903. ? *Branchiostoma californiense*, Tattersall, (*nec* J. G. Cooper), *Ceylon Pearl Oyster Rept.*, I, p. 216, pl. i, figs. 14, 15.
1922. *Branchiostoma elongatum*, Franz (in part), *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 405.
1927. *Branchiostoma elongatum*, Franz (in part), *Ergebn. Anat. Entwickelung.*, XXVII, p. 483.

FIG. 3.—*Branchiostoma gravelyi*, sp. nov. Lateral view. × *ca.* 5.

Tattersall referred with some doubt a specimen from the Cheval District, Ceylon, to Cooper's species *Branchiostoma californiense*, and remarked that the Ceylon specimen " differs but very slightly from either *B. californiense* or *B. capense* ". Franz considered *B. capense* to be probably a " geographische Varietät " of *B. elongatum* (Sundevall), but considered *B. californiense* as distinct. He also doubtfully referred Tattersall's *B. californiense* from Ceylon to *B. elongatum* (Sundevall), even though he gave the distribution of this species as " Westküste Südamerikas ".

The rostral fin (text-fig. 3) is almost continuous with or separated by a shallow notch from the dorsal and is only slightly produced into a snout-like structure. The dorsal fin is low and has a continuous series of fine rays. The caudal fin is a little higher than the dorsal and ventral fins ; the infra-caudal lobe is slightly longer and deeper. The ventral fin is very long, and has a series of double fin rays throughout its entire length, but the fin chambers do not extend postanally. The metapleural folds terminate symmetrically.

The oral cirri are moderately long, about 30 in number, and bear well-marked, almost triangular, sense-papillae. The " Räderorgan " agrees with Tattersall's description.

The notochord extends far in front of the anteriormost myotome and slightly beyond the last myotome. The nervous system projects anteriorly to almost the beginning of the rostral fin. There is no eye-spot.

All the specimens are apparently immature as no gonads can be seen.

The measurements and myotome formula of 4 specimens are as follows :—

Length 44 mm. Myotomes 41—18—10=69.
Length 41 mm. Myotomes 40—18—10=68.
Length 36 mm. Myotomes 40—18—10=68.
Length 23 mm. Myotomes 40—18—10=68.

This form, as the above description shows, agrees very closely with Tattersall's single specimen from Ceylon which he recorded doubtfully as *B. californiense*, but differs in myotome formula and the absence of the eye-spot. I am inclined to consider the differences as of little value and believe that the specimens before me are conspecific with Tattersall's form. They, however, differ materially from *B. californiense* and *B. elongatum*, and I propose to separate them under the name *B. gravelyi*, sp. nov. with the following diagnosis :—

Myotomes 68-69, with the general formula 40—18—10. Rostral fin rather low, only slightly or not marked off from the dorsal. Caudal fin beginning about 2 myotomes in front of the anus dorsally and extending ventrally about 5 myotomes beyond it. Posterior end distinctly pointed. Ventral fin chambers not extending postanally. Preoral tentacles moderately large with distinct, triangular sense papillae. Length up to 44 mm.

Distribution.—About a dozen specimens of this species were dredged from off Coilapatam, S. W.×W. of Tuticorin on 30. iii. 28 by the Madras Fisheries Trawler " Lady Goschen ".

Holotype.—F 11675, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—*B. gravelyi* is allied to *B. elongatum*, but differs in its myotome formula, form and extension of the fins, and the entire absence of the eyes.

Genus **Asymmetron** Andrews.

Asymmetron cingalense (Kirkaldy).

1895. *Amphioxus (Heteropleuron) cingalense*, Kirkaldy, *Quart. Journ. Microsc. Sci.*, XXXVII, p. 315, pl. xxxv, fig. 7.
1903. *Asymmetron cingalense*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 301.
1903. *Asymmetron cingalense*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 217.
1922. *Asymmetron cingalense*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVII, p. 425.
1927. *Asymmetron cingalense*, Franz, *Ergebn. Anat. Entwickelung.*, XXVII, p. 484.

A. cingalense is represented in the collection before me by 7 specimens dredged from Tholayiram par, 10-16 fathoms, on 28. iii. 1928.

The specimens vary from 21-27 mm. in length and the myotome formula is 8-9, 15-16, 26-37. In one specimen, a male, 15 gonads were present on the right side. In other repsects the specimens agree very closely with the descriptions of Kirkaldy and Tattersall.

TWO NEW COPEPODS OF THE GENUS *ACARTIA* FROM BURMA.

By Adolph Steuer, *Rovigno d' Istria, Italy.*

(PLATE V.)

Recently Mr. F. Kieffer of Dieselberg near Heidelberg handed over to me for identification the two Copepods described in this note. The specimens had been collected near Myitkyo about 100 miles north-east of Rangoon, Burma, on 6th February, 1933, and were found in the Sittang River and the Sittang-Pegu Canal. According to a communication of Mr. Kieffer the collection also contained the Copepods *Mesocyclops leuckarti* and *M. hyalinus.*

A few specimens of the two new forms have been deposited in the Zoological Museum, Berlin.

Acartia (Acartiella) sewelli, sp. nov.

(Pl. V, figs. 1-7.)

♀: Total length, 1·38-1·57 mm.

The 1st abdominal segment (*Ab* 1-3) is without the row of transverse spines and the scattered spines on its dorsal surface such as were described by Sewell for *A. tortaniformis* (2, p. 346). During copulation the neck-piece of the spermatophore is introduced beneath the valve (pl. v, fig. 1) which lies dorsally on the left side close to the posterior end. The right furcal ramus is somewhat longer than the left; the 2nd furcal seta is scarcely thickened.

The fusion of the proximal segments of the first antenna (pl. v, fig. 2) is more advanced than in *A. tortaniformis,* and ventrally on the posterior surface there are traces of "triangular spines" in the form of minute chitinous knobs. Spines are entirely absent on the distal segments.

On the 2nd antenna (pl. v, fig. 3), B1 protrudes globularly from the inner edge as in *A. clausi* Giesbr. (see Giesbrecht **1**, p. 514, pl. **xxx**, fig. 13). The two ramii of the 2nd antennae have been differently interpreted in *A. clausi* by Giesbrecht (*op. cit.*) and in *A. tortaniformis* by Sewell (**2**, p. 347, pl. xxi, fig. 4). Following Giesbrecht's terminology, the exopodite of *A. sewelli* is fused with the second basal joint (B2 Re), and the free endopodite (Ri1-2) is directed forwards. In addition to the more proximal two setae, B2 bears on its inner margin a third seta; this is wanting in *A. tortaniformis.* The outer margin of the endopodite is straight in *A. sewelli*, but is sharply bent in *A. tortaniformis.*

The exopodite of the 5th leg (pl. v, fig. 4) bears on its inner margin a row of strong teeth, while along the outer margin there is only a small bristle.

♂: Total length, 1·27-1·51 mm.

On the 1st abdominal segment (pl. v, fig. 5) the genita opening lies on the left; the right furcal ramus is conspicuously longer than the left.

The grasping antenna lies on the right; the proximal segments of the left antenna are less fused than those of the female and the chitinous knobs are even further reduced.

Concerning the succession of joints in the 5th leg (pl. v, fig. 6) I have already expressed my views (**5**, pp. 13, 101); these differ from those of Sewell (**2**) for the nearly allied species *A. tortaniformis.* In the present species the "endopodite" which arises from the ventral surface, is much smaller than in Sewell's species. On the right leg on Re1 a curved bristle is present in addition to the two straight ones on the dorsal inner margin. Re2-3 is much less bent than in *A. tortaniformis* and has a few short hairs externally near the base of the distal spine; the latter bears hairs along its inner margin. On the left leg Re2-3 bears on its outer margin a projection with a short spine and a well developed tuft of hairs.

The new species, which I have dedicated to Col. R. B. Seymour Sewell, the well known student of Indian Copepods, is very closely allied to *A. tortaniformis* Sewell. The latter species, however, may be regarded as a little more primitive, as in the female the fusion of the joints of the 1st antenna is not so far advanced. In the 2nd antenna the notch on the outer margin of the endopodite still indicates its formation by the fusion of two segments.

In one female a large nematode ($1500\mu \times 56\mu$) was found. This probably belongs to the genus *Philometra,* as the intestinal caeca characteristic of the genus *Contracoecum,* were not visible (see Wülker, **6**, p. 2). The anterior end bears a small boring spine; the posterior is "spitz geschwanzt" (pl. v, fig. 7).

Epistylis lacustris Imhoff kindly determined for me by Dr. A. Kahl of Hamburg, was found attached to a number of specimens.

Acartia (Acanthacartia) chilkaensis Sewell var. **sittangi,** nov.

(Pl. V, figs. 8-14).

♀: Total length, 1·06-1·15 mm.

The head bears a rostrum and is separated from Th1 (pl. v, fig. 8). Th4-5 is rounded; laterally it is minutely spinose both on the ventral and dorsal surfaces and the ventral spines (about 5) are larger than the more numerous dorsal (pl. v, fig. 9).

On the 1st antenna (pl. v, fig. 10) segments 15-24 bear a delicate row of minute spines ventrally on its posterior margin.

The basal region of the terminal claw of the 5th leg (pl. v, fig. 11) is ventrally thickened and somewhat bent in the middle; often a distinct tooth is found in this situation on the outer margin. The terminal piece is feathered along both sides.

♂: Total length 1·00-1·06 mm.

The abdomen (pl. v, fig. 12) bears dorsally on its distal margin from Ab1-Ab4 a row of minute spines which is continued to the ventral side on Ab2 and Ab3.

On the grasping antenna (pl. v, fig. 13), which is on the right side, the 17th segment bears a small spine on its upper surface; this may be identical with the "spine-like tooth-plate" which Sewell (**3**, p. 10)

mentions but which he does not figure. The same spine is also to be found on the left antenna in the same location. On Aa 19-21, a chitinous knob is present proximally; this sometimes terminates in a sharp point.

On the 5th right leg (pl. v, fig. 14) Re1 bears a bristle about the middle of the ventral side. Re2 has on its inner side a somewhat quadrangular plate, but lacks the distal process figured by Sewell for *A.* (*A.*) *chilkaensis* (3, pl. ix, fig. 5). On the other hand it bears on its distal margin the little bristle which occurs there very frequently. A similar one is present on Re2 in the middle of the concave inner margin; this is mentioned by Sewell in his description, but not shown in fig. 5. The terminal spine is small and blunt.

On the left leg, B1 is indicated in Sewell's figure and B2 appears divided, as a result of which the distal piece would be the 1st joint of the exopodite. The position of the bristle of the outer margin indicates undoubtedly that it is the 2nd basal joint. In my specimens the "rounded projection" on the inner margin of this segment is only very feebly indicated, and the bristle of the outer margin arises at a distance from it. The terminal joint Re2-3 (=Exopodite 3 of Sewell) is somewhat more complicated in the specimens from the Sittang River. It terminates in a large bent cone which bears a terminal spine. From the base of the second proximal spine starts a delicate veil-like membrane, which seems to be absent in the typical form.

The new variety is distinguished from the typical form by the following characters:

(1) In the female the 1st antenna in the typical form bears, according to Sewell, transverse rows of minute spines only on the 16th, 17th and 19th segments, while in the variety *sittangi* the rows extend from the 15th to the 24th segments. The row of the 18th is very feebly developed. In the 5th leg, Sewell figures the terminal claw as smooth; I have found minute hairs along its lateral borders.

(2) In the male, the armature of the abdomen is different. In the typical form the abdomen is naked, in the new variety Ab1-4 bear rows of minute spines. On the right 5th leg the distal outgrowth of the quadrangular plate of Re2 is absent, and on the left Re2-3 the base of the proximal spine bears a delicate membrane.

The specimens from the Sittang River are larger than those from the Chilka Lake; the averages for the two forms are:

♀: 1·10 mm. (as compared to 0·75 mm. in the *forma typica*).

♀: 1·03 mm. (as compared to 0·70 mm. in the *forma typica*).

Sewell (3, p. 10) noted that he had also examined some males from Cochin[1] which resembled his species, but which were somewhat larger (0·82 mm.) than the Chilka Lake specimens. These had a row of minute spines on the posterior margin of the abdominal segments 2, 3 and 4. He was inclined to regard these specimens from Cochin "as a local variation," as they agreed in all characters with the Chilka Lake

[1] This sample is not mentioned in Sewell's later work (4, p. 395).

specimen. The specimens from the Sittang River seem to be more closely related to those from Cochin, than to the *forma typica* from the Chilka Lake.

Of all species of the subgenus *Acanthacartia* so far known from India, *A. chilkaensis* is most closely allied to *A. plumosa* Th. Scott.

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EXPLANATION OF PLATE V.

Acartia (Acartiella) sewelli, sp. nov.

FIG. 1.—Last thoracical segment (Th 4-5) and abdomen (with spermatophore). ♀, dorsal view.

FIG. 2.—Left 1st antenna, proximal joints, ♀ from below.

FIG. 3.—2nd antenna, ♀.

FIG. 4.—5th leg, ♀.

FIG. 5.—Last thoracic segment and abdomen, ♂, dorsal view.

FIG. 6.—5th leg, ♂, ventral view.

FIG. 7.—Anterior part of the body of a ♀ with parasitic Nematode.

Acartia (Acanthacartia) chilkaensis Sewell var. *sittangi*, nov.

FIG. 8.—♀, dorsal view.

FIG. 9.—Last thoracic segment and abdomen (with spermatophores). ♀, lateral view.

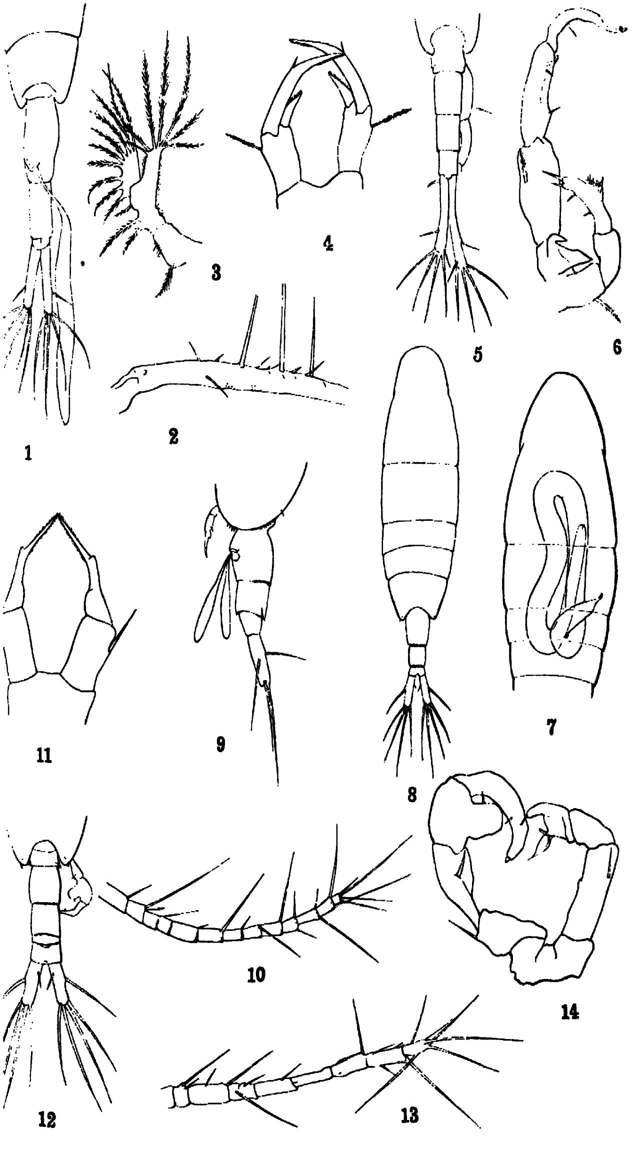
FIG. 10.—Left 1st antenna, terminal joints, ♀, from below.

FIG. 11.—5th leg, ♀.

FIG. 12.—Last thoracic segment and abdomen, ♂, dorsal view.

FIG. 13.—Right grasping 1st antenna, terminal joints, ♂, from above.

FIG. 14.—5th leg, ♂, ventral view.



New Copepods of the Genus *Acartia*.

FURTHER OBSERVATIONS ON THE BIONOMICS OF THE EARLY STAGES OF TORRENTIAL LEPIDOPTERA FROM INDIA.

By SUNDAR LAL HORA, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(PLATE VI.)

Though the existence of aquatic Lepidoptera has been known for a long time, our knowledge of the torrential forms is comparatively recent. In 1909, Poulton [1] published an account of the life-history of a torrential species—*Aulacodes simplicialis* Snell—based on observations made in China by Kershaw and Muir. Five years later, Llyod[2] discovered in America a species of *Elophila* with similar habitat and, in 1927, I[3] directed attention to the occurrence of Lepidopterous larvae and pupae in the hill-streams of India. It was pointed out that similar larvae had previously been collected from India by Drs. F. H. Gravely and B. N. Chopra, and were present in the collection of the Zoological Survey of India. In 1928, Pruthi [4] published certain observations on the biology and morphology of the immature stages of *Aulacodes peribocalis* Wlkr. Some of the views expressed by Pruthi are at variance with those of mine, but as the proper elucidation of the subject required further observations in the field, no reference was made to Pruthi's article in my monograph[5] on the "Ecology, Bionomics and Evolution of the Torrential Fauna." Since 1930, the bionomics of these insects has been studied by me on three different occasions in the Tista Valley where torrential Lepidoptera are found in great abundance in suitable places in all the streams of the Valley. It has thus been possible to check and verify observations made at different places on different occasions and the results given below are based on a thorough and extensive investigation of the problem. Some of these results have been briefly referred to in my account of the "Silken Shelters of Torrential Insect-Larvae"[6].

HABITAT.

In February 1927, torrential Lepidopterous larvae were found by me in great abundance in the Nerbuda river near Pharisemar in the Rewa State, Central Provinces. In places the bed of the shallow stream was stony without any large boulders and the current was fairly rapid. The stones had a profuse growth of filamentous algae and such places were the chief haunts of the larvae of *Aulacodes*; their silken shelters were covered with a rich growth of algae. In other parts of the river, where the rocks were without any visible vegetation but had a cover of slimy

[1] Poulton, *Trans. Ent. Soc. London*, pp. xl-xliv (1909).
[2] Lloyd, *Journ. N. Y. Ent. Soc.*, XXII, pp. 145-152 (1914).
[3] Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXII, pp. 124-126 (1927).
[4] Pruthi, *Rec. Ind. Mus.*, XXX, pp. 353-356 (1928).
[5] Hora, *Trans. Roy. Soc. London*, (B) CCXVIII, pp. 201, 202 (1930).
[6] Hora, *Current Science*, I, p. 341 (1933).

matter, only a few larvae in suitable situations were found. In places the bed of the stream consisted of a single, flat rock over which the water flowed with considerable speed. Such places were also found to be the favourite resorts of the *Aulacodes* larvae. These observations on the habitat of the larvae have been confirmed by visits to the Tista Valley. It was found that the larvae prefer rapids, but are not usually found in very fast currents, such as on the lips of falls or rocks at the bases of waterfalls.

Smooth rocks are usually devoid of silken shelters, but only rough rocks, especially those with small fissures and crevices, are preferred by the Lepidopterous larvae. The young larvae take shelter in these unevennesses of the rocks and cover themselves with silken sheets which they go on extending according to their requirements. As a rule, the silken shelters are more extensive on bare rocks than on algae-covered rocks. The significance of this is explained later (p. 343).

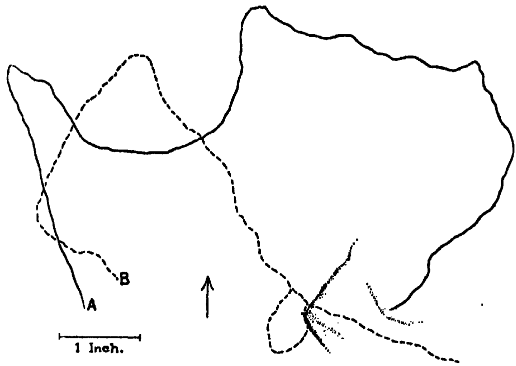
Apparently, therefore, there are two factors which determine the presence or absence of Lepidopterous larvae in a suitable stream, (i) the rapidity of the current and (ii) the nature of the surface of the rocks forming the beds. Thus the torrential Lepidopterous larvae and pupae show a marked habitat preference. In suitable places, I have found small pieces of stones with six or seven larvae (plate vi, fig. 2) and in the Lupchu-Jhora under the bridge on the Rangit-Darjeeling Road I found about 60 pupal cases on a rock with a surface of about 2 square feet exposed to the current. The rock was lying on the edge of the stream and only a portion of it was being washed by a moderate current. The biological factors, such as food, enemies, etc., have not been considered in the above account.

SILKEN SHELTERS.

The silken shelters are turgid and fully distended under water in swift currents, but they collapse partially when taken out. I have explained elsewhere (*op. cit.*, 1933) the physical principles that bring this about, but it is necessary to reiterate that the water flows with greater speed over the shelter than underneath the silken sheet. This differential rate of flow produces low pressure above the shelter and pulls it upwards.

Efforts were made to study the process of manufacture of the silken sheet by the larva, but it was difficult to observe the animal under natural conditions for a long period. A suitable piece of stone was selected, and all the larval shelters were removed from it. It was then placed in its old position in a rapid. After obstructing the current from flowing over this piece, a larva was placed on it and as soon as it had secured a firm hold on the stone, the current was allowed to run over it with full force. The animal at first crawled towards the leeward edge of the stone and then turned back from the edge. On finding a groove in the stone, it lay there quietly. A second larva was then placed on the same stone and it behaved in the same way, except that on finding a groove, it did not abandon its search for a more suitable place. It made periodic excursions, but finding no other place more suitable, it returned to the

same groove. It became dark and the observations could not be continued, but a few larvae were brought to the camp and left in water in petrie dishes. By morning all the larvae, whether young or old, had formed silken shelters (plate vi, figs. 1 & 3) of a somewhat flimsy nature between the bottoms of the dishes and their walls. In manufacturing the sheets the larvae must have touched the bottoms and the sides of the dishes alternately in a criss-cross fashion so that a meshed pattern was formed by the salivary threads. The older larvae spun a more



Tracts of two Lepidopterous larvae (A and B) marked on a piece of stone as it lay in a rapid, Kalijhora stream, Tista Valley.

close-meshed sheet than the younger ones. The silken sheets (plate vi, fig. 6) of the natural shelters manufactured in the course of the swift currents are fairly thick and consist of several of layers of threads closely placed together in the manner indicated above. These sheets become covered with algae, Diatomes, slime and fine particles of sand, etc., that drift in the current and become fairly compact structures for the larvae to live in safety. The grooves on pieces of stones, no doubt, provide starting places for the manufacture of silken sheets.

At the time of pupation, a larva strengthens a part of the larval shelter which then becomes somewhat brownish in colour. The entire complicated structure of the cocoon[1], including the pillars, strands, etc., is manufactured with the help of the salivary secretion and is not due to any mineral deposition on the web. The cocoon was kept in strong nitric acid for several minutes and no effervescence was noticed. The cocoon did not suffer in any way by this treatment. The outer brownish wall of the cocoon (plate vi, fig. 5) is very thick and tough, almost leathery, and appears to be composed of several layers of silken sheets.

The above observations do not bear out Pruthi's statement that the "power of secreting silk for making a fresh shelter is very much limited"

[1] For the details of the structure of the cocoon, see Pruthi, *Rec. Ind. Mus.*, XXX, p. 355 (1928).

in mature larvae. In captivity, without food, the mature larvae manufactured shelters again and again though, through mere exhaustion, the mesh became flimsier with every fresh effort. The capacity for the production of silk is probably greatest in the larvae just before pupation.

PROGRESSION.

The caterpillar usually lies quietly under its silken shelter and I have never observed it moving about. If, however, it is disturbed, it moves from one part of the shelter to another and is very reluctant to leave it. When forced out or when the silken sheet is removed, the larva moves towards the under side of the rock, especially if the day light is strong. Progression is effected in the usual way with the help of the thoracic legs and the abdominal prolegs. The larva moves fairly quickly in a series of forward waves. In the case of larvae kept in a petric dish, it was observed that they poured out salivary secretion along the paths (plate vi, figs. 1 & 4) of their progression, so that the claws of the thoracic legs and hooks of the abdominal prolegs could take a firm hold of the substratum. When a larva was lifted from a dish, a salivary thread was pulled out with it. It seems probable that in nature the caterpillar behaves like a *Simulium* larva which uses its hooks and salivary secretion for progression [1]; the latter helps in providing a secure substratum in which sharp points can be fixed. It also seems probable that, in nature, if a caterpillar is detached from its moorings, it hangs on to the rock by means of its salivary thread, by which it can probably crawl back to its shelter.

It is known that "tent-caterpillars" (*Malacosoma*, Family Lasiocampidae) lay out extensive paths of silky secretion over which they travel during their foraging expeditions. The silky secretion of the larvae of torrential Lepidoptera provides a suitable substratum on which the animal can progress securely and rapidly. I believe the larvae come out from underneath the silken sheets at night and wander about on it for feeding purposes (*vide infra*).

In a dish of water, when not crawling at the bottom, the larvae were observed to move fairly fast by means of the jerking movements of the body. There are no special organs for swimming and in nature the larvae probably never swim at all.

FOOD AND MODE OF FEEDING.

Recently I [2] advanced the view that the silken shelters of torrential insect larvae serve to snare or entangle food particles. The extensive sheets of the Lepidopterous larvae, when examined under a microscope, show a large amount of extraneous matter entangled in them and some are even thickly covered with a growth of filamentous algae. It has further been observed that whether the algal growth on the silken sheets is visible or not, its presence is readily detected by keeping a silken sheet in spirit which dissolves the chlorophyll and turns green instantly. Mr.

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[1] Hora, *Phil. Trans. Roy. Soc. London*, CCXVIII, p. 213 (1930).
[2] Hora, *Cur. Sci. I.*, p. 341 (1933).

K. P. Biswas, Curator of the Herbarium, Royal Botanical Garden, Sibpore (Calcutta), has very kindly studied the algae growing on the rocks harbouring Lepidopterous larvae and compared them with the algae growing on or entangled in the sheets and also with those found in the gut of the larvae. The material was, in all cases, collected from the Kalijhora stream below the bridges in the Tista Valley. Mr. Biswas has informed me that the species of algae, Desmids and Diatomes obtained from the three sources are the same. When mature larvae were put in spirit, some ejected from the mouth bundles of long filamentous algae, and this leaves no doubt that the larvae feed on the food they find in their neighbourhood. From an examination of the gut-contents of several individuals, Pruthi[1] found that "they mostly consist of, besides water, extremely minute particles of vegetable matter which are quite different in appearance and size from those usually found in the gut of a typical terrestrial caterpillar. It is highly probable, therefore, that the larvae depend for their nourishment on *minute bits of algae suspended in the surrounding water*" (Italics are mine). Pruthi and I are in agreement in regard to the nature of the food of these larvae, but we differ regarding the mode of collection of the same by the larvae.

Among the brook inhabitants, which I have studied for a number of years, I have found that those which have taken to feeding on microplanktonic organisms, have evolved complicated and ingenious devices to strain minute particles of food out of the rushing current. Among insects[2] reference may be made to the snares of the water-spiders (*Hydropsyche*, Trichoptera), to the fans of Simulium (Diptera) and to the bristle-fringed legs of *Chirotenetes* (Ephemeroptera) and *Brachycentrus* (Trichoptera). Reference may also be made to the feeding mechanism of the funnel-mouthed tadpoles of *Megalophrys*[3]. The mouth-parts of the torrential Lepidopterous larvae "are exactly like those of typical terrestrial caterpillar suitable for masticating tough leaves, etc." (Pruthi, p. 355). Thus there would seem to be no mechanism in the mouth-parts of these larvae to collect planktonic food, but there is no doubt that their larval shelters act as snares or gardens. The animals feed by making periodic excursions to the upper surfaces of the sheets; the under surface is usually devoid of vegetable growth. It is also possible that the larvae wander about at night on the parts of the rock in the vicinity of the shelters and pick up algae and other food material. In any case, the larva has to bite off its food from a solid substratum and not to pick up the floating particles.

In the parts of the streams where there is a rich growth of algae, etc., the silken shelters of the Lepidopterous larvae are small and covered with filamentous algae; whereas the shelters on the bare rocks are vast and extensive. This shows that with the presence of abundant food-material in the form of algae, etc., small sheets are enough to entangle sufficient quantities of food for the requirements of the larvae inhabiting them.

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[1] Pruthi, *Rec. Ind. Mus.*, XXX, p. 354 (1928).
[2] Needham & Lloyd, *Life in Inland Waters*, p. 365 (1916).
[3] Hora, *Rec. Ind. Mus.*, XXX, pp. 139-144 (1928).

EXPLANATION OF PLATE VI.

Silken Shelters of Torrential Lepidoptera.

FIG. 1.—Photograph of the bottom of a petrie dish showing the paths of silky secretion laid out by torrential Lepidopterous larvae, and 5 silken shelters manufactured by them in the course of a night. *Nat. Size.*

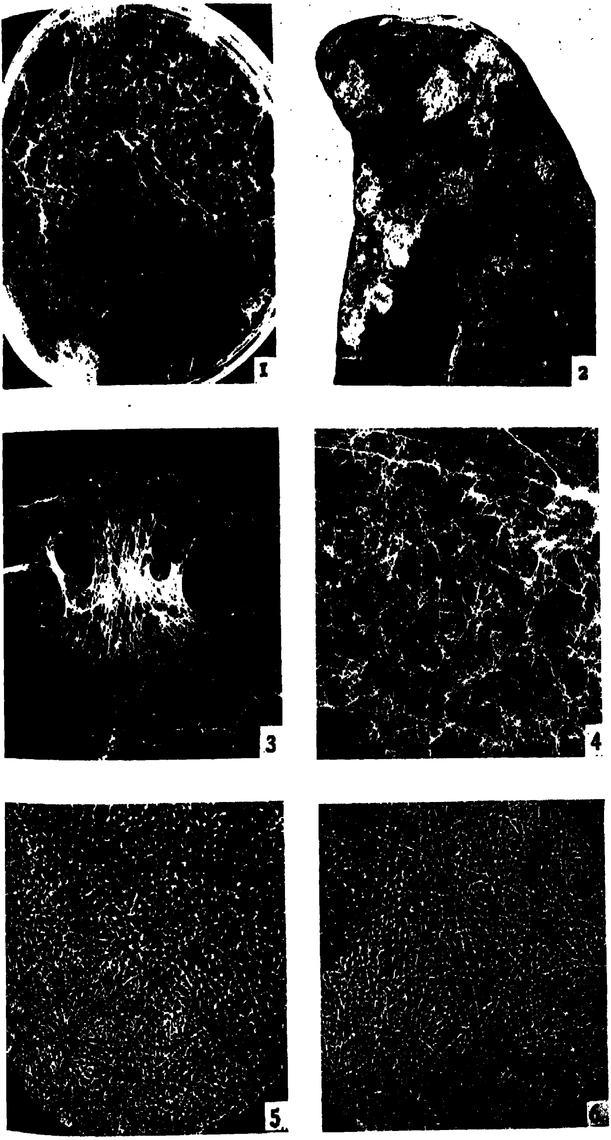
FIG. 2.—A portion of a stone picked up from a rapid in the Kalijhora stream, Tista Valley, showing a number of larval shelters of Torrential Lepidopterous larvae.

FIG. 3.—A silken shelter manufactured by a Torrential Lepidopterous larva in a petrie dish. $\times 3$.

FIG. 4.—Paths of silky secretion laid out by Torrential Lepidopterous larvae at the bottom of a petrie dish. $\times 3$.

FIG. 5.—Microphotograph of a portion of the uppermost, brownish, thick sheet of the cocoon of a Torrential Lepidopterous pupa. $\times 300$.

FIG. 6.—Microphotograph of a portion of the natural silken shelter of a Torrential Lepidopterous larva, showing the structure of the thick sheet and of the extraneous matter entangled in it. $\times 300$.



Silken Shelters of Torrential Lepidoptera.

ON A NEW INDIAN LEECH, *HEMICLEPSIS VIRIDIS*, SP. NOV.

By JOHN E. CHELLADURAI, *M.A., Department of Zoology, The Science College, Trivandrum.*

Material.—Two specimens of the new species were first obtained on December 8, 1927; both were young and were seen in a basin of water containing *Hydrilla* collected from a freshwater tank at Trivandrum, Travancore. Since then water with *Hydrilla* was regularly examined and on January 30, 1928, a full grown specimen with young ones clinging to its ventral side was obtained. Though a periodical search was thereafter maintained no further specimens were obtained till August 15, 1929, when a medium-sized specimen was collected. The stomachs of all the four specimens were empty and colourless and therefore indistinct. Later in November, 1929, specimens were seen on the common tank frogs, *Rana hexadactyla* and *R. tigrina*. Since then several specimens of different sizes were obtained from time to time from these frogs. All of these had their stomachs fully gorged with blood.

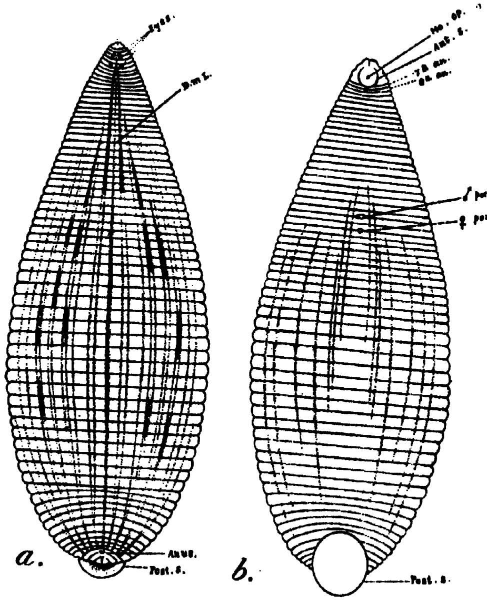
Chief features.—(1) Eyes three pairs. (2) Stomach with more than seven pairs of caeca. (3) Mouth opening in the middle of the oral sucker. (4) Fifteen to twenty-five pea-green sub-parallel longitudinal lines on the dorsal surface.

Dimensions.—(1) Of a full grown preserved specimen:—Length, 8 mm., greatest breadth, 3·7 mm., width of posterior sucker, 1·2 mm.

(2) Of a living specimen resting in a dish of water:—Length, 24 mm., greatest breadth, 3 mm.

Description.—When at rest the body is ovate-lanceolate. The head is faintly dilated. The dorsal surface bears minute uniform papillae in a transverse line across the middle of each annulus. The colouration is characteristic of the species. The dorsal surface of a full grown specimen bears fifteen to twenty-five bright pea-green longitudinal sub-parallel lines, which have the following arrangement: mid-dorsally there is a bright dark green line, this begins between the second and third pairs of eyes and runs to the peduncle of the posterior sucker. On either side there are seven to twelve lines which are most distinct about the middle region of the body. Of these, the two paramedian lines converge and unite posteriorly. Anteriorly they unite with each other and merge into the dorsomedian line behind the last pair of eyes. The other lines tend to converge and unite in groups posteriorly but in front they remain distinct. All are composed of numerous close-set pigment spots. When these are well developed the lines are distinct and continuous; otherwise they appear as dotted lines. In very young specimens all the lines appear as serial rows of dots. The ventral surface also bears a few lighter lines. There is no ventro-median line. In a full grown specimen seven to nine lines of unequal length are seen on either side. They are mostly confined to the post-gonoporal region. In some specimens the ventral surface is diffusely pigmented throughout.

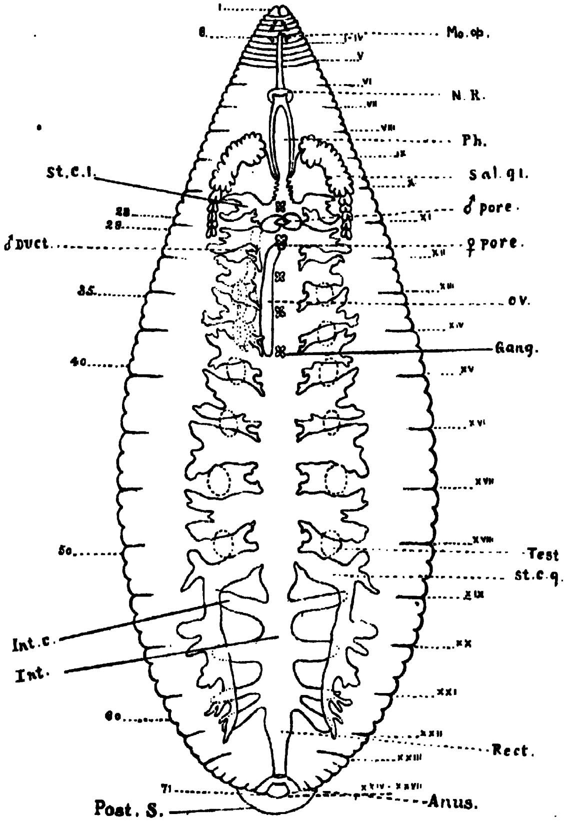
Eyes.—There are three pairs of eyes arranged in two sub-parallel rows in annuli three, four, and six. The eyes of the first pair are the smallest and their pigment cups are directed forward with a slight oblique tilt. The eyes of the second pair are large and are but a shade smaller than those of the third. Their pigment cups are directed obliquely forward. The eyes of the third pair are the largest and are directed obliquely backward. The ratios between the diameters of the first, the second and the third pair of eyes are as 3·5 : 6 : 7.



TEXT-FIG. 1.—*Hemiclepsis viridis*, sp. nov. ×11½.
a. Colour pattern of dorsal side; *b.* Colour pattern of ventral side.
Ant. S.=anterior sucker; *D. M. L.*=dorso-median line; *Mo. op.*=mouth opening; *Post. S.*=posterior sucker; *7th an.*=seventh annulus; *8th an.*=8th annulus.

Annulation.—The annuli are 71 in number. Two annuli, the first and the second, are pre-ocular. Somites I to IV are formed by the first seven annuli. Somites V to XXIII are complete and each is triannulate. Somites XXIV to XXVII are formed by the last seven annuli. Between annuli 69 and 70 is placed the anus, and there are two post-anal annuli. On the ventral side the seventh annulus forms the posterior margin of the oral sucker. The male pore is conspicuous and is placed between annuli 28 and 29, *i.e.*, between somites XI and XII. The female pore is minute and is placed two annuli behind the male in the interannular furrow between the second and the third annuli of somite XII.

Suckers.—The anterior sucker bears the minute mouth aperture in its centre. In a freshly killed specimen, the position of the mouth is clearly visible. The posterior sucker is, as usual, circular in outline.



TEXT-FIG. 2.—Annulation and internal structure of *Hemiclepsis viridis*, sp. nov. ×17.

1 to 71=annuli; I to XXVII=somites; *Gang.*=ganglion; *int.*=intestine; *Int. C.*=intestinal caecum; *Mo. op.*=mouth opening; *N. R.*=nerve ring; *Ov.*=ovary; *Ph.*=pharynx; *Post. S.*=posterior sucker; *Rect.*=rectum; *St. C. 1*=first stomach caecum; *St. C. 9*=ninth stomach caecum; *Sal. gl.*=salivary gland; *Test.*=Testes.

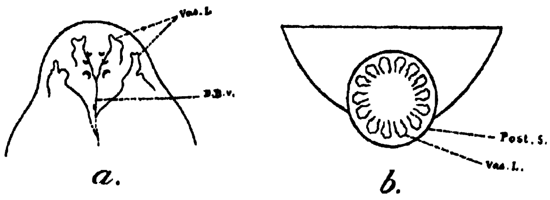
Alimentary System.—The mouth is placed in the centre of the oral sucker. Since the position of the mouth is an important feature, its location in the middle of the oral sucker was carefully noted. Living specimens were observed under a microscope and as the anterior end was waved about on the slide before fixation, the mouth was distinctly visible in the middle of the oral sucker. In freshly fixed specimens also

the mouth appeared as a triradiate pore in the middle of the oral sucker. Finally from longitudinal serial sections of the anterior half of the body the position of the mouth within the anterior sucker was confirmed.

When the anterior sucker contracts, its margin becomes slightly wrinkled and presents an undulating line. Due to the wrinkling there is a constant and comparatively more distinct furrow in the antero-median edge of the sucker.

The pharynx is slender. The salivary glands are well developed and form on either side a compact mass. They extend from the middle of the retracted pharynx to the posterior limits of the second pair of the caeca of the stomach. A distinct salivary duct opens behind the caudal termination of the pharynx. The stomach has nine pairs of lobed caeca. When the stomach is fully distended with blood, the inter-caecal regions also become expanded into the lateral lobed pockets. The first pair of caeca is small. The remaining caeca show a gradual increase in size from front to back. The last pair is the largest and extends far back towards the posterior sucker. The intestine has the usual complement of four pairs of caeca. They are directed laterally, the first pair with a slightly forward and the last pair with a slightly backward inclination. The rectum opens through the anus which is placed two annuli in front of the posterior sucker.

Vascular System.—The following few points were noted regarding the vascular system. The dorsal blood vessel at its anterior end bifurcates just behind the level of the third pair of eyes. Each of its two branches runs forward below the second pair of eyes. Near the margin of the sucker it bends back, the backward arm of the loop being



TEXT-FIG. 3.—*Hemiclepsis viridis*, sp. nov.

a. Vascular loops of anterior sucker ×34; *b.* Vascular loops of posterior sucker ×16⅔.

D. B. V.=dorsal blood vessel; *Post. S.*=posterior sucker; *Vas. L.*=vascular loops.

external to the forward one. A second pair of vascular loops from the dorsal blood vessel, which starts a little behind the first pair, also enters the anterior sucker, the two arms of each loop being disposed as before. The posterior sucker is provided with the full complement of seven vascular loops.

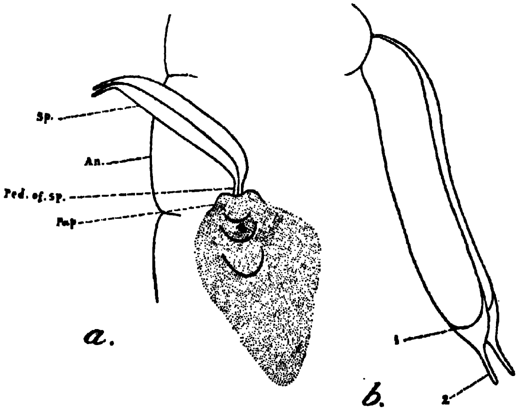
Nervous System.—The nerve ring is placed in somite VII.

Reproductive System.—The testes are six pairs. The two ovarian tubes are distinct. Their length depends upon the state of development

of the ova. When the ova are immature the ovarian tubes extend back only a short distance behind the female pore. When, however, the ova are ripe and ready for laying, they are very long and extend far backwards, their hind ends reaching the level of the origin of the last pair of caeca of the stomach.

The number of eggs laid at a time is variable and probably depends upon the condition of nutrition of the specimen before egg laying. In two specimens the count was 82 (specimen obtained on September 4, 1932) and 52 (specimen obtained on September 12, 1932).

A periodical search for specimens with spermatophores proved eventually successful. Three specimens with spermatophores were obtained, two on September 12, 1932, and one on September 13, 1932. One of these bore a single spermatophore on its left lateral border; and each of the others bore three spermatophores. Of the latter, one had all the spermatophores attached to the ventral side and the other had two on the ventral and one on the dorsal side. The spermatophores appear to be scattered without any apparent order and more than one spermatophore may be deposited on a single leech. The freshly attached



TEXT-FIG. 4.—*Hemiclepsis viridis*, sp. nov.

a. Spermatophore ×60; *b.* Empty spermatophore. Diagrammatic.

An.=annulus; *Pap.*=papilla on body wall to which spermatophore is attached: *Ped. of sp.*=pedicle of spermatophore; *Sp.*=spermatophore; 1=convex surface of sperm mass; 2=finger-like termination of spermatophore.

spermatophore has the outline of a minute double cucumber. Its proximal end, which forms a common pedicle, is attached to a papilliform projection of the skin. The distal end of each half terminates in a slender finger with a very narrow lumen. The tips of the two finger-like ends are covered over by a quantity of mucus. Since the spermatophore is fixed only by the pedicle, it freely waves about whenever the leech moves. The wall of the spermatophore is thin and transparent.

Dimensions of the spermatophore in a fixed specimen :—

Length excluding the distal finger	440μ
Width	100μ
Length of distal finger	77μ
Width of finger near its base	11μ

One of the spermatophores appeared to be newly fixed. It was nearly full and whitish in colour. Near its distal end at the base of each of the finger-like processes there was a clear, crescentic space which indicated that the spermatophore had just begun to empty its contents.

This spermatophore was kept under observation and the process of the discharge of the sperm mass was continuously watched. The sperm mass at the distal end of the spermatophore presented a distinct convex surface which gradually moved towards the pedicle, as the sperm mass passed into the body wall of the leech. In twenty-five minutes the spermatophore was completely empty and allowing a few minutes for what was expelled before the observation began, one is led to conclude that it takes about half an hour for a spermatophore to empty itself.

The sperm mass that passed into the body wall of the leech could be seen for a time as a spreading white drop.

Observations on habits, etc.—The leech often rests on the stem or on a leaf of *Hydrilla*. In the latter case it places itself lengthwise on the leaf fitting itself snugly in the upper angle of the slightly folded leaf. In either position, its dark green colour blends with that of the plant and the leech cannot be easily distinguished.

If disturbed while resting on *Hydrilla* or on the side of a dish, the leech detaches itself, curls up into a ball with the ventral side inside and drops down. This is a habit common to most Glossiphonids.

While resting on the side of a dish or when attached to a frog, the little leech often keeps up a gentle oscillation of its body which helps to renew the water surrounding it. This movement is probably useful in respiration.

For sucking blood, the leech attaches itself to any part of the frog's skin. I have picked off specimens from near the eye, the middle of the back, the sides of the legs and the web between the toes. A few were found on the lower side also, where alone they were conspicuous against the whitish background of the frog's skin. Fixing itself by both its suckers, the leech continues to suck blood till its stomach is filled to its utmost capacity. Then the stomach region shows itself through the body wall as a very distinct dark red region. The caeca of the stomach are so much expanded that they press against each other, and their limits are not clear. The dilated caeca also extend very close to the lateral margin of the body wall. Even the intercaecal lobes of the stomach become distended into lateral lobed pockets. When such a specimen is mounted alive on a slide, the gentle pressure of the cover slip is sufficient to force a little of the blood into the pharynx. A specimen with an empty stomach was observed from time to time while feeding and it was seen that the last pair of caeca of the stomach became filled first and then the others in order from back to front. But when a specimen with a full stomach was kept in a basin of water and examined

from day to day, it was found that the first pair of caeca which were the last to fill were the first to become empty and the other caeca became empty in order from front to back.

The leech moves off from the frog when the ova are ripening and attaches itself to the leaf or the stem of some water plant. Here it slowly digests its full meal of blood and the caeca of the stomach become gradually empty. Then the maturing ovary can be seen through the body wall. the outline of each developing ovum being distinctly visible. By the time the ova are ripe for laying, the stomach has become completely empty. It is while resting on the water plant that the eggs are laid and these adhere to the ventral side of the leech. During this period, though the stomach is quite empty, the leech does not feed. Specimens carrying eggs, when gently dropped on a frog resting in a basin of water, promptly moved off and fixed themselves to the sides of the basin. As long as the ova cling to the parent's body, the ventral surface of the leech forms a shallow concave surface in which the ova are accommodated. Should the leech now gorge itself with blood, the ventral surface would flatten out and the ova would be in danger of being rubbed off whenever the leech moved about. It is possible that the starvation habit during this period is to safeguard the eggs.

After hatching, the young ones cling by both their suckers to the body of the parent. A freshly hatched young is colourless with the exception of the pigment cups of the eyes. Its stomach with its caeca is distinct but it is completely filled with yolk granules. It cannot feed for a time till all the yolk is absorbed. Specimens with young ones, when dropped on a frog, fix themselves to it, but after a partial meal of blood move off from the frog. That the meal was partial was decided by the condition of the stomach which was bright red in colour with distinct caeca, the full stomach being dark red in colour with indistinct caecal limits.

Occurrence.—Trivandrum and Ootacamund. The specimens that I collected were all obtained from Trivandrum, either from the local fresh-water tanks from among *Hydrilla*, or from the local frogs. Prof. Percy Moore, when he was in India three years ago on his collecting tour, was shown one of my slide specimens and my sketches. He then told me that he had collected similar leeches from Ootacamund which he picked off from the under side of the leaves of the water lily. He also presented me two of his specimens for comparison with mine.

Position of the present Species.—The genera *Hemiclepsis* and *Paraclepsis* agree in having more than seven pairs of stomach caeca, but differ in the following respects :—

	Hemiclepsis,	*Paraclepsis.*
(1)	Eyes typically two pairs.	Eyes typically three pairs.
(2)	Mouth opening within the oral sucker.	Mouth opening subterminal, leaving the oral sucker imperforate.

The present species agrees with *Hemiclepsis* in having the mouth opening within the oral sucker, and with *Paraclepsis* in having three pairs of eyes; but as the position of the mouth within the oral sucker is a more important feature than the number of eyes, I have placed my new

species for which I propose the name *viridis* in the genus *Hemiclepsis*. *H. viridis*, however, tends to lessen the differences between the genera *Hemiclepsis* and *Paraclepsis*.

I am indebted to Prof. J. Percy Moore who read through the manuscipt and made various corrections.

The type of *H. viridis* is deposited in the Indian Museum, Calcutta.

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NOTES ON FISHES IN THE INDIAN MUSEUM.

XXIII. On a Collection of Fish from the S. Shan States, Burma.

By Sunder Lal Hora, *D.Sc.*, *F.R.S.E.*, *F.A.S.B.*, and Dev Dev Mukerji, *M.Sc.*, *Zoological Survey of India, Calcutta.*

During the field-season of 1933-34, Mr. V. P. Sondhi of the Geological Survey of India made a traverse through the country between the Lawksawk and Kēngtūng States of the Southern Shan States in Burma. In the course of the journey, Mr. Sondhi worked in the drainage basins of three principal rivers, namely, the Irrawaddy, the Salween and the Mekong. The exigencies of his service did not permit him to devote much time to the collection and preservation of fish, but, all the same, he availed himself of this opportunity to collect some material in all the three basins. The collection is of considerable interest as in addition to the three new species from the Lawksawk canal and the Salween River at Takaw it contains specimens of several species not hitherto represented in the collections of the Indian Museum.

The country traversed by Mr. Sondhi is hilly in the main and consists of high hills and valleys. The collection was made from pools or slow-running streams and, therefore, lacks in typical torrential forms, with the exception of two species of *Garra*. We give below a list of localities with the names of the species of fish collected therefrom and a short description of each locality as supplied to us by Mr. Sondhi.

Irrawaddy Drainage System.

1. Paddy fields at Gaunphpo, Lawksawk State. November, 1933.

"The paddy fields at Gaunphpo are irrigated by water diverted from small rapid streams issuing from the hills to the west of the Gaunphpo plain. The fish were caught from fields irrigated by the Chaung Cyi stream."

i. *Lepidocephalichthys berdmorei* (Blyth) . . . . 1 specimen.

2. Chaung Gyi stream, north-west of Gaunphpo, Lawksawk State. November, 1933.

"A moderately torrential stream with a bed of large, rounded boulders. The water is clear and devoid of vegetation. The fish were caught from a small pool with a sandy bottom after stunning them by shooting into the water."

i. *Barbus sarana caudimarginatus* Blyth . . . 2 specimens.
ii. *Danio (Danio) aequipinnatus* (McClelland) . . 13 specimens.
iii. *Nemachilus rivulicola* Hora . . . . 1 specimen.
iv. *Lepidocephalichthys berdmorei* (Blyth) . . . 1 specimen.

3. Lawksawk Canal at Lawksawk, Lawksawk State. April, 1934.

"Just south of the town of Lawksawk is a large perennial spring that gives rise to a small lake, about half a furlong across. The lake is almost chokeful of vegetation which can be clearly seen through the crystal clear water, the actual bottom of the lake is rarely seen. The discharge or overflow from the lake is diverted into a canal which runs along the eastern end of the town. As the canal is aligned and dug by local people

it is not uniformly graded throughout and has therefore pools and rapids at different points in its course. The sluggish portions are usually full of vegetation and in rapids a pebbly or coarsely sandy bottom is seen. As the spring issues from limestones, the water is highly charged with lime."

i. *Barbus tor* (Ham. Buch.) . . . . . . 2 specimens.
ii. *Barbus sarana caudimarginatus* Blyth . . 2 specimens.
iii. *Barbus shanensis*, sp. nov. . . . . . . 2 specimens.
iv. *Garra gravelyi* (Annandale) . . . . . 2 specimens.

SALWEEN DRAINAGE SYSTEM.

4. A tributary of the Salween on the east bank at Takaw, Kēngtūng State. January, 1934.

" A torrential stream with rocky bed. The water is clear and devoid of vegetation. Only one specimen of fish was obtained by shooting into the water near the edge."

i. *Ophicephalus gachua* Ham. Buch. . . . . . 1 specimen.

5. The Salween River at Takaw, Kēngtūng State. 21st January, 1934.

" The Salween river at Takaw has a strong current and a deep channel. It is difficult to catch fish in the dry months, but during the monsoon, when the water rises to cover the sloping banks, fish are extensively caught in shallow embayments formed in places. The fish were netted from a pool in the course of the river."

i. *Osteochilus sondhii*, sp. nov. [*Pa-sat*][1] . . . 2 specimens.
ii. *Garra salweenica*, sp. nov. [*Pa-ing*] . . . 2 specimens.

6. Stream at Hsenmawng, Kēngtūng State. 28th January, 1934.

" The stream at Hsenmawng is very torrential, and the bed consists of huge boulders of granite and coarse sand. The water is clear and devoid of vegetation. The fish were obtained by shooting into stationary water behind large boulders."

i. *Lepidocephalichthys berdmorei* (Blyth) . . 1 specimen.
ii. *Ophicephalus gachua* Ham. Buch. . . . . 1 specimen.

MEKONG DRAINAGE SYSTEM.

7. Kēngtūng, Kēngtūng State. Market specimens. 1st February, 1934.

i. *Cyprinus carpio intha* Annandale . . . . . 1 specimen.
ii. *Mystacoleucus marginatus* (C. V.) . . . . . 2 specimens.

8. Nawng Kyawk tank at Kēngtūng, Kēngtūng State. 2nd February, 1934.

" Nawng Kyawk is a small artificial lake. Its water is slightly turbid so that the bottom is not seen below a few feet."

i. *Clarias batrachus* (Linn.). [*Pa-lupp-pawn & Pa-lupp-lumm*] . . . . 2 specimens.
ii. *Lepidocephalichthys berdmorei* (Blyth). [*Pa-soo*] . 2 specimens.
iii. *Monopterus albus* (Ziew). [*Pa-yin*] . . . . 2 specimens.
iv. *Ophicephalus striatus* Bloch. [*Pa-ko*]. . . 1 specimen.
v. *Trichopodus trichopterus* (Pallas). [*Pa-shep*] . 2 specimens.
vi. *Betta splendens* Regan. [*Pa-kut*] . . . . 2 specimens.

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[1] Names in square brackets are the local names of the species.

9. Nam MeHsai stream, Kengtüng State. 14th and 16th February, 1934.

"Nam MeHsai is the boundary stream between the British territory and Siam. At the point at which the fish were caught the stream enters the plain and loses its torrential character. The channel is wide and shallow and in the dry months the water is confined to a narrow course in the wide bed of the stream. The water is turbid and carries lot of drift wood. The bed is covered with coarse sand and shingle."

i. *Mystus*[2] *bleekeri* (Day) . . . . . . 1 specimen.
ii. *Barbus puntio* (Ham. Buch.) Day . . . . 1 specimen.
iii. *Crossochilus latius* (Ham. Buch.) . . . . 1 specimen.
iv. *Mystacoleucus marginatus* (C. V.) . . . . 2 specimens.
v. *Rasbora taytayensis* Herre . . . . . 2 specimens.
vi. *Lepidocephalichthys berdmorei* (Blyth) . . . 1 specimen.
vii. *Acanthopsis choirorhynchus* (Blkr.) . . . . 1 specimen.
viii. *Ophicephalus gachua* Ham. Buch. . . . . 1 specimen.
ix. *Trichopodus trichopterus* (Pallas) . . . . 6 specimens.
x. *Betta splendens* Regan . . . . . . 2 specimens.
xi. *Anabas testudineus* (Bloch). . . . . . 2 specimens.

10. Nam Hōk stream east of Hawnglūk. 15th February, 1934.

"Nam Hōk is a large stream with a sluggish current and steep banks. The bed consists of mud and sand and is devoid of any vegetation. The water is turbid."

i. *Clarias batrachus* (Linn.) . . . . . . 1 specimen.
ii. *Barbus sophore* (Ham. Buch.) . . . . . 2 specimens.
iii. *Ophicephalus striatus* Bloch. . . . . . 1 specimen.
iv. *Trichopodus trichopterus* (Pallas) . . . . . 2 specimens.
v. *Anabas testudineus* (Bloch) . . . . . 1 specimen.

11. Nam Long stream a mile west of Mong Hpayak, Kengtüng State.

"The stream is large and torrential with crystal clear water and a bed covered with large boulders and sand. There is no vegetation in the stream bed. The fish were caught by shooting into the water of a clear shallow pool which was about a foot deep. The fish were present in a thick shoal over a hot sulphur spring. The sandy bed of the pool was unbearably hot and there was a strong smell of sulphuretted hydrogen. The fish were living in warm water about eight inches above the hot sand."

i. *Barbus* spp. Juvenile . . . . 5 specimens.

4 specimens with a smooth dorsal spine and 1 with a serrated spine.

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[2] In 1919, Jordan (*Genera of Fishes*, p. 269) pointed out that the generic name *Macrones* (Dumeril 1856, orthotype *Bagrus lamarii* Cuv. & Val.) was preoccupied in Coleoptera (Newman 1841) and proposed *Aoria* to replace it. In spite of this, *Macrones* is still being used by a number of ichthyologists, both Indian and foreign, and *Aoria* has been only partially adopted. Fowler (*Journ. Bombay Nat. Hist. Soc.*, XXXII, p. 105, 1928), however, pointed out that *Aoria* Jordan was not a suitable name, as three Bleekerian generic names—*Hemibagrus*, *Hypselobagrus* and *Aspidobagrus* (*Atlas Ichthyol.*, II, pp. 54, 57, 59, 1862)—were available to replace *Macrones*. At the same time, it was indicated that *Mystus* Gronow, a much earlier name, was originally used for Bagrid fishes of the type of *Macrones* and had thus precedence over all other names. After careful consideration, we agree with Fowler and have adopted the name *Mystus* for species of the genus *Macrones*.

Mystus Gronow (*Zoophylaceum*, p. 124, 1763, type *Silurus pelusius* Solander) was introduced by Scopoli (*Introd. Hist. Nat.*, p. 451, 1777) but the name was originally used by Russell in the 1st edition of his History of Aleppo in a popular sense for a Bagrid fish, but in the 2nd edition of the work Solander designated it *Silurus pelusius* (Günther, *Cat. Fish. Brit. Mus.*, V., p. 431, 1864). One of the typical specimens from Russell's collection is described by Günther in his *Catalogue* (p. 75) and the description leaves no doubt that *Macrones* is synonymous with *Mystus*.

It may be pointed out that *Aoria* is also preoccupied among Coleoptera (Baly, *Journ. Ent.*, II, p. 49, 1863) and is, therefore, not available for fishes.

Of the 79 specimens listed above, it has not been possible to determine specifically 5 very young specimens of *Barbus* obtained from the Nam Long stream. The remaining 72 specimens are referable to 24 species, the majority of which belong to the order Cyprinoidea as is clear from the list given below :-

CLARIIDAE.

Clarias batrachus (Linn.)

BAGRIDAE.

Mystus bleekeri (Day).

COBITIDAE.

Acanthopsis choirorhynchus (Bleek.).
Lepidocephalichthys berdmorei Blyth.
Nemachilus rivulicola Hora.

CYPRINIDAE.

Rasbora taytayensis Herre.
Danio (Danio) aequipinnatus (McClell.).
Cyprinus carpio intha Annandale.
Mystacoleucus marginatus (Cuv. & Val.).
Osteochilus sondhii, sp. nov.
Barbus shanensis, sp. nov.
Barbus sarana caudimarginatus Blyth.
Barbus tor (Ham. Buch.).
Barbus puntio (Ham. Buch.) Day.
Barbus sophore (Ham. Buch.).
Crossochilus latius (Ham. Buch.).
Garra salweenica, sp. nov.
Garra gravelyi (Annandale).

SYMBRANCHIDAE.

Monopterus albus (Ziew).

OPHICEPHALIDAE.

Ophicephalus striatus Bloch.
Ophicephalus gachua Ham. Buch.

ANABANTIDAE.

Anabas testudineus (Bloch).
Betta splendens Regan.
Trichopodus trichopterus (Pallas).

With the exception of the three new forms—*Osteochilus sondhii*, *Barbus shanensis* and *Gara salweenica*—and three other species, *viz.*, *Rasbora taytayensis*, *Garra gravelyi* and *Barbus puntio*, the remaining species are quite well known and do not call for any comments. We have, however, added a short note on the colouration of *Danio aequipinnatus* to amend our recent key to the species of the subgenus *Danio.*

Very little is known about the ichthyology of Burma as a whole, and the fish of the upper reaches of the Salween River have received practically no attention so far. It is not surprising, therefore, that both the species collected by Mr. Sondhi at Takaw in the Salween River have proved to be new. The occurrence of *Rasbora taytayensis* in the Nam McHsai stream, a tributary of the Mekong River, is remarkable as the species was so far known from the Philippines. Mr. Sondhi's small collection has added materially to our knowledge of the fishes of Burma and we are grateful to him for affording us an opportunity to investigate such an interesting material. We have to thank Dr. B. Prashad for his kindness in going through the manuscript and Mr. R. Bagchi for the drawings which he has executed with his usual skill and care under our supervision.

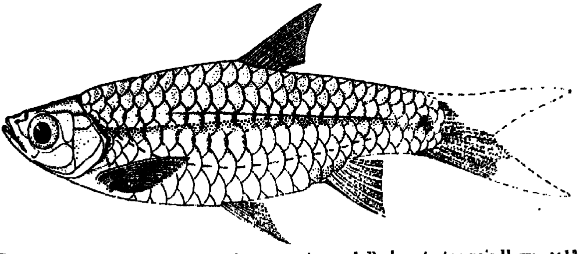
Rasbora taytayensis Herre

1924. *Rasbora taytayensis*, Herre, *Philippine Journ. Sci. Manila*, XXIV, pp. 264, 265.

In Mr. Sondhi's collection there are two specimens of *Rasbora* from the Nam McHsai stream which agree in all essential respects with *R. taytayensis* Herre from the Philippines. The only differences that we can notice are (i) the presence of two lateral bands in *R. taytayensis* and only one in the Nam McHsai specimens, and (ii) 15-17 perforated scales in *R. taytayensis* and 18-20 in the specimens under report. These differences are not of much diagnostic value and will probably be bridged over when large series of specimens are examined from Burma and Siam. Unfortunately Herre did not publish a figure of his species, and as it is here recorded from a place widely separated from the type-locality, we describe our specimens in detail and figure one of them.

D. 3/7 ; A. 2/5 ; P. 14 ; V. 8-9 ; C. 18.

In the Nam McHsai species of *Rasbora* the dorsal profile is slightly arched while the ventral profile is deeply concave. The head is small and pointed ; its length is contained from 4·7 to 5 times in the total length



TEXT-FIG. 1.—Lateral view of the larger specimen of *Rasbora taytayensis* Herre. × 1½.

and 3·8 times in the length without the caudal. The height of the head at the occiput is contained 1·4 times and the width from 1·9 to 2·2 times

T 2

in its length. The eyes are lateral, large and prominent; their diameter is contained 3 times in the length of the head, from 0·7 to 0·8 times in the length of the snout and 1·2 times in the interorbital width. The interorbital space is flat and wide. The mouth, lips and jaws are as in the genus. The cleft of the mouth ascends strongly, its anterior end is almost in level with the upper border of the eye while the posterior just misses the level of the anterior border of the eye.

The commencement of the dorsal is slightly behind that of the ventral, and is nearer the base of the caudal than the tip of the snout. The longest ray of the dorsal is considerably shorter than the depth of the body below it. The pectoral fin is long and pointed but does not extend to the base of the ventral. The ventral fin is similar to the pectoral but its outer rays are prolonged and it is separated from the anal by a short distance. The anal fin is short and does not reach the base of the caudal. The caudal fin is deeply forked; the lobes are long and pointed, the lower lobe is slightly longer than the upper.

The depth of the body is contained from 3·8 to 4·6 times in the total length and from 3·1 to 3·5 times in the length without the caudal. The larger specimen is proportionately much deeper. The caudal fin is contained 4·4 times in the total length. The body is covered with large and well-marked scales. There are about 25 to 26 scales in a longitudinal series between the upper angle of the operculum and the base of the caudal fin. There are 10 to 12 predorsal scales and 12 round the caudal peduncle. The lateral line is concave and incomplete; the number of perforated scales varies from 18 to 20 and the lateral line does not seem to extend to the caudal peduncle. There are 4½ or 5 rows of scales between the lateral line and the base of the dorsal and 1 or 1½ rows between it and the base of the ventral. Anteriorly the lateral line organs are continued above the eyes. The bases of the ventrals and anal fins are provided with scaly sheaths. In one of the specimens there are scaly appendages in the axils of the ventral fins. The least height of the caudal peduncle is contained from 1·4 to 2 times in its length. The caudal peduncle of the smaller specimen is long and slender.

The fish has a silvery sheen, the upper half is somewhat darker than the lower. There is a broad, faint band along the middle of the body which ends in front of the caudal in an oblong, black mark. The head and body are marked with small black dots which are aggregated along the margins of the scales. An aggregation of black spots at the base of the anal forms a narrow band. There is a black streak along the dorsal surface.

Locality.—Nam McHsai stream forming the boundary between the British Territory and Siam.

Remarks.—*Rasbora taytayensis* belongs to the group of species in which the lateral line is incomplete, and the origin of dorsal is behind that of ventral. According to Rendahl [1], its close ally is *R. vegae* from the Island of Labuan.

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[1] Rendahl, *Arkiv. f. Zoologi*, XVIII B, No. 13, p. 113 (1926).

Measurements in millimetres.

Total length including caudal	48·6	58·2
Length of caudal	11·0	12·1
Depth of body	10·5	15·0
Length of head	9·7	12·3
Height of head at occiput	7·0	9·0
Width of head	4·3	6·5
Length of snout	2·3	3·4
Diameter of eye	3·3	4·1
Interorbital width	4·0	5·0
Length of pectoral	8·4	10·6
Length of ventral	8·4	9·0
Longest ray of dorsal	9·0	11·7
Longest ray of anal	8·5	8·8
Length of caudal peduncle	9·0	10·0
Least height of caudal peduncle	4·3	7·2

Danio (Danio) aequipinnatus (McClelland)

1934. *Danio (Danio) aequipinnatus*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 131.

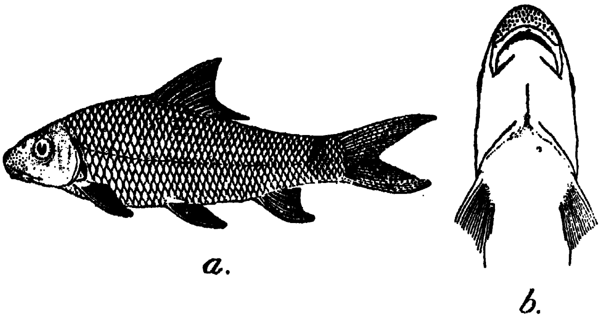
In our recent key to the species of the subgenus *Danio*, *D. aequipinnatus* was included among a group of species with "A well-defined black mark near upper angle of gill-opening." Some of the specimens collected by Mr. Sondhi in the Chaung Gyi stream near Gaunphpo do not bear this mark, but the species can be readily recognised by the characteristic colouration of the body.

Osteochilus sondhii, sp. nov.

D. 4/12; A. 3/5; P. 17; V. 9; C. 19.

In *Osteochilus sondhii* both the profiles are considerably arched; the dorsal profile rises from the tip of the snout to the commencement of the dorsal fin with a gradual, but steep, gradient, behind which it slopes gradually to the base of the caudal fin. The ventral profile is more evenly arched and in the region of the caudal peduncle is straight and horizontal. The body is considerably compressed, though somewhat flat on the ventral surface in front of the ventral fins. The head is short, thick and broadly pointed; its length is contained from 4·4 to 4·6 times in the total length without the caudal. The height of the head at the occiput is contained from 1·2 to 1·3 times and its width from 1·4 to 1·7 times in its length. The eye is placed in the upper half of the head and is just visible from the ventral surface; its greater part is situated in the posterior half of the head. The diameter of the eye is contained from 3·5 to 3·9 times in the length of the head; from 1·3 to 1·6 times in the length of the snout and from 1·4 to 1·8 times in the interorbital width. The nostrils are situated in front of the eyes at a distance of half its diameter. The snout is covered with sharp tubercles which extend backward to the front margin of the eyes. The mouth is distinctly inferior, horizontal and crescent-shaped; it is as wide as the length of the snout and is bordered by fleshy lips. The anterior lip is slightly fimbriated, but the

posterior one is distinctly papillated. Both the jaws are covered with a horny substance, that of the posterior jaw forms a sharp edge anteriorly.



TEXT-FIG. 2.—*Osteochilus sondhii*, sp. nov.
a Lateral view of the type-specimen. $\times \frac{1}{2}$.
b. Ventral surface of head and anterior part of body of the type-specimen. Nat. size.

The maxilla extends to just below the anterior margin of the eye. The maxillary groove is deep and contains a small maxillary barbel which is not visible from outside. There are no rostral barbels. The labial groove is broadly interrupted in the middle. The gill-opening is mostly restricted to the side and extends to the ventral surface only for a short distance. The operculum is provided with a broad membranous flap.

The commencement of the dorsal fin is opposite the 12th perforated scale and is much nearer to the tip of the snout than to the base of the caudal; it is in advance of the ventrals. The last spine of the dorsal fin is as long as the head and considerably longer than the base of the fin. The pectoral fin is shorter than the head; its outer rays are the longest and the fin is separated from the ventral by a distance greater than the diameter of the eye. The ventral fin is similar to the pectoral and does not extend to the anal-opening. The anal fin, when laid flat, does not reach the base of the caudal. The caudal fin is slightly longer than the head and is deeply forked with both the lobes pointed. The upper lobe is longer than the lower.

The depth of the body is contained from 3·4 to 3·7 times in the total length without the caudal. The scales are closely set and adhere firmly; there are 39 to 40 perforated scales along the lateral line, seven rows above it to the base of the dorsal fin and 5 rows below it to the base of the ventral fin. There are about 22 scales round the caudal peduncle and 16 scales in front of the dorsal fin. The least height of the caudal peduncle is contained from 1·4 to 1·7 times in its length.

In preserved specimens the dorsal surface and the sides are grayish while the ventral surface is much lighter. Every scale on the sides and the dorsal surface is provided with a black mark at its base, thus longitudinal rows of spots are formed. In the posterior region the entire border of each scale is darker, imparting a very characteristic colouration

to the species. A dull round spot near the root of the caudal fin is visible in both the specimens, while the smaller specimen is marked with a vertical patch of dull colour extending above and below the lateral line in the region of the 5th and 6th perforated scales. There is a broad, black mark behind the gill-opening. The caudal and the dorsal fins are tipped with black.

Mr. Sondhi noted that the colouration in the living specimens was "Light yellowish pink, sides pearly with a splash of orange dots. A shade of pink in the tail and keel fins."

Local name.—*Pa-sat.*

Locality.—Two specimens of the species were netted by Mr. Sondhi from the Salween River at Takaw in the Kēngtūng State on the 21st January, 1934.

Type specimen.—F. 11600/1, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—*Osteochilus sondhii* differs from all the seventeen species included by Weber and Beaufort in their account of the fishes of the Indo-Australian Archipelago (Vol. III, p. 124, 1916) by the following combination of characters:—

(i) There are 39 to 40 scales along the lateral line; 7 rows above it to the base of the dorsal fin and 5 rows below it to the base of the ventral fin.
(ii) The snout is covered with a large number of tubercles.
(iii) There are only two short, maxillary barbels.
(iv) There are only 12 branched rays in the dorsal fin.
(v) The caudal peduncle is surrounded by 22 scales.
(vi) Colouration.

The above characters also separate the new species from the three Burmese species of *Osteochilus* described by Day in his *Fishes of India* (pp. 545, 546). *O. chalybeatus* from the Irrawaddi and Salween Rivers possesses 54 scales along the lateral line and 8 rows above it to the base of the dorsal fin. The number of branched rays in the dorsal fin is 18, and there are four barbels. *O. neilli* from "Sittoung and Billing" possesses 15-16 branched rays in the dorsal fin, four barbels and only 34 scales along the lateral line. The systematic position of *O. cephalus* from Pegu is somewhat doubtful, but presuming that Day had examined the type-specimen before he wrote his description, it is clear that the new species agrees with *O. cephalus* in having fewer rays in the dorsal fin, 40 scales along the lateral line, many pores on the snout and one short pair of maxillary barbels. The two species, however, differ in the relative position of the fins and proportions. In *O. cephalus* "the dorsal commences midway between the snout and the base of the caudal", whereas in *O. sondhii* the commencement of the dorsal is distinctly nearer to the tip of the snout than to the base of the caudal. In the former "The anal laid flat reaches the caudal," while in the latter the two fins are separated by a considerable distance. In *O. cephalus*, the eye is "1/5 of length of head, 2 diameters from end of snout," while in *O. sondhii*, the eye is contained from 3·5 to 3·9 times in the length of the head and from 1·3 to 1·6 times in the length of the snout. Judging from Cuvier and Valen-

cienne's figure of *O. cephalus* (pl. 487), the two species appear to be abundantly distinct in their general facies.

The species of *Osteochilus* recently described, *O. prosemion* Fowler [1] from Cheing Mai, Upper Siam, *O. salsburyi* Nichols and Pope [2] from Hainan and *O. kükenthali* Ahl [3] from Borneo, possess 4 barbels and differ from the new species either in proportions, colouration, number of rays in the dorsal fin or in the number of scales along the lateral line.

Osteochilus sondhii is the 5th species to be recorded from the Burmese waters. Besides the three species mentioned by Day, Mukerji [4] recorded *O. vittatus* from the Mergui District, Lower Burma. It seems probable that with an extension of our knowledge of the ichthyology of Burma, more species of this interesting genus will be discovered. The range of the genus does not extend to India proper.

Measurements in millimetres.

Total length without caudal	106·6	121·2
Length of caudal	damaged	27·0
Depth of body	29·0	35·7
Length of head	23·8	26·3
Height of head at occiput	18·2	22·0
Width of head	14·0	18·0
Length of snout	8·0	12·0
Diameter of eye	6·0	7·5
Interorbital width	8·8	13·8
Length of pectoral	20·5	24·7
Length of ventral	18·0	23·0
Longest ray of dorsal	23·6	26·8
Length of anal spine	18·0	20·0
Length of caudal peduncle	16·4	23·0
Least height of caudal peduncle	12·5	15·7

Barbus shanensis, sp. nov.

D. 4/8 ; A. 3/5 ; P. 15-16 ; V. 8-9 ; C. 19.

In *Barbus shanensis* the dorsal profile rises gradually from the tip of the snout to the commencement of the dorsal fin ; in the region of the base of the dorsal it falls down abruptly but beyond the dorsal it slopes down gradually to the base of the caudal fin. The ventral profile is deeply, but evenly, arched throughout. The body is greatly compressed and the back between the dorsal fin and the head is ridge-like. The head is short and almost pointed at the tip ; its length is contained from 4·2 to 4·6 times in the total length without the caudal. The height of the head at the occiput is contained from 1·1 to 1·3 times and the width from 1·6 to 1·8 times in its length. The eyes are moderately

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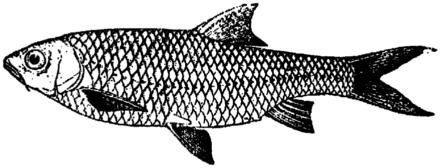
[1] Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 116 (1934).
[2] Nichols & Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 348 (1927).
[3] Ahl, *Sitzungsber. Gesell. Nat. Freunde Berlin*, p. 33 (1924).
[4] Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 286 (1932).

large and lateral in position : their diameter is contained from 3 to 3·5 times in the length of the head, from 1 to 1·1 times in the length of the snout and from 1·2 to 1·3 times in the interorbital width. The interorbital space is broad and almost flat. The snout is smooth. The mouth is deeply arched and the maxillary bone just extends to below the anterior border of the eye. The upper jaw projects in front of the lower so that the mouth is subinferior in position. There are four barbels ; the maxillary barbels are as long as the diameter of the eye while the rostrals are somewhat shorter.



TEXT-FIG. 3.—Lateral view of the type-specimen of *Barbus shanensis*, sp. nov. ×½.

The depth of the body is contained from 3 to 3·3 times in the length without the caudal. The height of the caudal peduncle is contained from 1·5 to 1·6 times in its length. The scales are thin and adhere to the body firmly ; there are 36 to 38 perforated scales along the lateral line and 6 or 6½ series between it and the commencement of the dorsal fin. There are 3 or 3½ series of scales between the lateral line and the base of the ventral fin. The number of predorsal scales varies from 15 to 16 and there are about 16 scales round the caudal peduncle. The scales on the ventral surface are somewhat smaller.

The commencement of the dorsal fin is considerably nearer to the base of the caudal than to the tip of the snout ; it is almost equidistant between the middle of the eye and the base of the caudal fin. The last dorsal spine is strong and denticulated ; the length of its bony portion is contained from 1·2 to 1·4 times in the length of the head. There are 16 pairs of teeth along the posterior border of the spine, and, with the exception of the last two, they are graded. The upper teeth are more widely spaced than the lower ones. The longest ray of the dorsal fin is considerably shorter than the depth of the body below it. The pectoral fin is long, narrow and sickle-shaped ; it is separated from the ventral by a considerable distance. The ventral fin is more extensive than the pectoral. The anal opening is situated just in front of the base of the anal fin, which is short and does not reach the base of the caudal fin. The caudal fin is longer than the head and is deeply bifurcate. The lobes are sharp and pointed.

The colouration of the spirit specimens is silvery gray above and silvery below. In the smaller specimen, the edges of the scales along the lateral line and of those above it are shot with small black dots which produce longitudinal series of black markings. These markings are most prominent along the lateral line. The distal half of the caudal fin, especially

of the lower lobe, and of the anal fin is dark. The dorsal fin is tipped with black. The distal half of the ventral fin is also grayish. The snout, behind the tip, is marked with a black patch.

Type-specimen.—F. 11625/1, *Zoological Survey of India, Indian Museum, Calcutta.*

Locality.—Lawksawk Canal at Lawksawk, S. Shan States, Burma.

Remarks.—As a result of recent researches on the ichthyology of Yunnan [1] and Upper Burma [2] a number of interesting species of the genus *Barbus* with 4 barbels and strong, serrated dorsal spine have been discovered. Unfortunately some of these have not been figured and their descriptions also are inadequate.

Barbus shanensis, differs from all the species hitherto described by the following combination of characters :—

(*i*) Length of head 4·2-4·6 times in length without caudal.

(*ii*) Eye 3-3·5 times in length of head and almost equal to length of snout.

(*iii*) Interorbital width 2·4-2·6 times in length of head.

(*iv*) 36-38 perforated scales along lateral line ; 6 or 6½ above it to base of dorsal and 3 or 3½ below it to base of ventral.

(*v*) 15-16 predorsal scales.

(*vi*) Commencement of dorsal considerably nearer base of caudal than tip of snout.

(*vii*) Strong dorsal spine with coarse and widely spaced teeth.

Judged by these characters, the new species comes very close to *Barbus gregorii* Norman. We have examined a co-type of the latter species almost as long as the type of *B. shanensis*, and from the general facies the two species appear to be quite distinct. Morphologically the differences lie in the size of the head and the eyes. In *B. gregorii* the length of the head is contained 3½-4 times in the length and the diameter of the eye 3¼-4¼ in the length of the head. Of the species known from the Southern Shan States and the adjacent parts of Upper Burma, *B. caltesii* Boulenger is closely allied to *B. shanensis*, but differs from it in having the commencement of the dorsal fin equidistant between the tip of the snout. and the base of the caudal fin, 12-13 predorsal scales and 29-33 scales along the lateral line.

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[1] Anderson, *Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875*, p. 868, pl. lxxix, fig. 1, 1878 (*Barbus margarianus*) : Regan, *Ann. Mag. Nat. Hist.* (7) XIII, pp. 190 & 191, 1904 (*B. grahami* and *B. yunnanensis*) : Chaudhuri, *Rec. Ind. Mus.*, VI, p. 16, 1911 (*B. huggini*) : Norman, *Ann. Mag. Nat. Hist.* (9) XI, p. 562, 1923 (*B. gregorii*).

[2] Boulenger, *Ann. Mag. Nat. Hist.* (6) XII, p. 201, 1893 (*Barbus caltesii* and *B. schanicus*) : Annandale, *Rec. Ind. Mus.*, XIV, pl. iii, figs. 3 & 4, 1918 (*Barbus sarana caudimarginatus* Blyth and *B. schanicus* Boulenger) ; Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, pp. 195-200, pl. ix, 1929 [*B. chagunio* (H. B.); *B. sewelli* : *B. myitkyinae* and *B. sarana caudimarginatus* Blyth]; Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 126, 1934 (*B. sarana* and its subspecies *caudimarginatus* and *sewelli*) : Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 64-68, 1934 [*B. clavatus burtoni*, *B. chagunio* (H. B.) *B. chola* (H. B.) and *B. sarana caudimarginatus* Blyth].

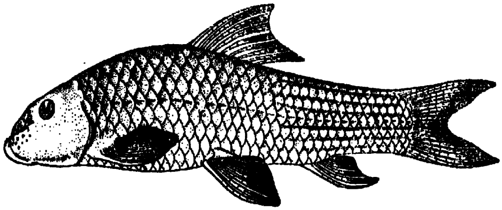
Measurements in millimetres.

Total length without caudal	104·6	128·5
Depth of body	34·8	38·3
Length of head	22·5	30·3
Length of snout	7·5	9·5
Diameter of eye	7·5	8·5
Interorbital width	9·4	11·3
Width of head	14·0	16·7
Height of head at occiput	20·0	23·4
Length of pectoral	22·3	27·0
Length of ventral	20·2	24·0
Length of bony portion of dorsal spine	18·7	21·3
Length of 1st branched ray of dorsal	20·0	23·3
Longest ray of anal	18·5	20·2
Length of caudal peduncle	19·3	20·3
Least height of caudal peduncle	12·0	13·3

Garra salweenica, sp. nov.

D. 3/8; A. 1/5; P. 16; V. 8; C. 19.

Garra salweenica is a stoutish species in which the dorsal profile rises abruptly from the tip of the snout to the dorsal fin. The ventral profile is almost horizontal and straight throughout. The body is depressed anteriorly but is moderately compressed in the posterior region. The head is flattish and tapers anteriorly; its length is contained 3·9 times in the total length without the caudal. The width of the head is contained 1·3 times and the height at occiput 1·4 times in its length. The eyes are small and situated in the posterior half of the head; their diameter is contained 6·2 times in the length of the head, 3·4 times in the length of the snout and 2·6 times in the interorbital width. The interorbital space is slightly convex and the eyes, though dorso-lateral in position, are considerably below the dorsal profile of the head. The snout

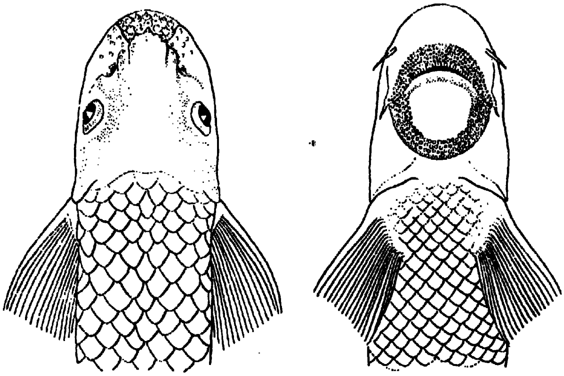


TEXT-FIG. 4.—Lateral view of the type-specimen of *Garra salweenica*, sp. nov. × [illegible].

has a prominent proboscis which is trilobed and free anteriorly; the lateral lobes are small but well defined. The area in front of the proboscis and two smaller areas at the sides of it are covered with 3 to 4 rows of large, spiny tubercles while there are a few similar tubercles on all the three lobes of the proboscis. The nostrils are situated at the base of the proboscis and are separated from each other by a membranous flap.

The rostral barbel is smaller than the diameter of the eye while the mandibular barbel is hidden in the labial groove and is hardly visible on the surface. The mental disk is well developed; its central, callous portion is large and prominent. The gill-openings extend to the ventral surface for a short distance and the distance between them is slightly greater than 2·5 times the diameter of the eye.

The dorsal fin commences in advance of the ventral and is distinctly nearer to the tip of the snout than to the base of the caudal; its last undivided ray is longer than the head but is shorter than the depth of the body. The paired fins are horizontally placed and their outer rays are provided with adhesive pads on the ventral surface; the pectoral fin is slightly shorter than the head and is pointed in the middle. The commencement of the ventral is almost equidistant between the tip of the snout and the base of the caudal; the ventrals extend beyond the anal opening and are separated from the anal by a distance equal to the diameter of the eye. The anal fin, when laid flat, does not reach the base of the caudal. The caudal fin is deeply forked; the lobes are pointed, the lower lobe being somewhat better developed and slightly longer than the upper lobe.



a. *b.*

TEXT-FIG. 5.—*Garra salweenica*, sp. nov. × 1½.
a. Dorsal surface of head and anterior part of body.
b. Ventral surface of head and anterior part of body.

The depth of the body is contained 3·8 times in the total length without the caudal. The scales are large and adhere firmly to the surface; there are about 33-34 perforated scales along the lateral line, 3½ rows above it to the base of the dorsal, 3 rows below it to the base of the ventral fin. There are about 9 predorsal scales and 16 scales round the caudal peduncle. The scales on the ventral surface are reduced and those between the bases of the pectoral fins are very small. The scaly appendage in the axil of the ventral fin is well developed. The length of the caudal peduncle is 1·2 times its least height.

The species of *Garra* possess, more or less, a similar type of colour pattern, but in this species the dorsal surface is much more gray than is usually the case. The dorsal surface of the outer rays of the paired fins, especially of the pectorals, is deep black, and the lower lobe of the caudal fin with the exception of a small distal portion and a small part of the upper lobe are infuscated with gray. The branched rays of the dorsal fin and the inner rays of the anal fin are also black. The black mark, usually present in species of *Garra*, near the upper angle of the gill-opening is absent; but a series of spots at the base of the dorsal fin and longitudinal streaks of gray colour along the sides of the body, especially in the tail region, are present.

Type-specimen.—F. 11602/1, *Zoological Survey of India, Indian Museum, Calcutta.*

Locality.—The Salween River at Takaw Kĕngtūng State, Southern Shan States, Burma.

Local Name.—Pa-ing.

Remarks.—The above description is based on the type-specimen, but there is another specimen, 71·7 mm. in total length without the caudal, from the type-locality which we also refer to *G. salweenica*. In the young example, the proboscis is not well developed and there is just a faint indication of its three-lobed condition. The colouration is similar to that of the type-specimen but its proportions are different. The depth of the body is contained 4·2 times and the length of the head 4·8 times in the total length without the caudal. The width of head is contained 1·1 times and the height at occiput 1·2 times in its length. The diameter of the eye is contained 4·9 times in the length of the head, 2·6 times in the length of the snout and 2·4 times in the interorbital distance. The least height of the caudal peduncle is contained 1·3 times in its length. Both the pectorals and the last undivided ray of the dorsal are considerably longer than the head. These differences from the type-specimen are due, in our opinion, to the immaturity of the second specimen, otherwise the two are conspecific.

Relationships.—Of the large number of species of *Garra* known to us from India and other neighbouring countries, there is no form in which the proboscis is trilobed in the way described above for *G. salweenica*. The trilobed condition in *G. bicornuta* Rao [1] is due to the development of two horn-like structures in front of the eyes and above the nostrils. The only species in which the structure of the proboscis is similar to that of *G. salweenica* is *G. arabica* Hora.[2] Unfortunately the colouration of the latter species is not known, but the two forms seem to differ in general facies and proportions. In several respects, *G. salweenica* approaches *G. fuliginosa*, a species recently described by Fowler [3] from N. Siam (Metang River, 35 miles north of Chieng Mai) and *G. schismatorhyncha* Nichols and Pope [4] from Hainan; but differs from them in the character of the proboscis and proportions. Judging from Fowler's figure of his species, the two forms seem to differ greatly in physiognomy.

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[1] Rao, *Ann. Mag. Nat. Hist.* (9) VI, p. 57, pl. i (1920).
[2] Hora, *Rec. Ind. Mus.*, XXII, p. 677, text-fig. 5 (1921).
[3] Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 139, figs. 108-111 (1934).
[4] Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 358, fig. 25 (1927).

Attention may here be directed to *Garra lamta (sensu lato)* recorded by one of us[1] from N. Burma. In this form the proboscis is broad and extensive, but not trilobed. The lateral tubercular areas were mistaken for the lateral lobes of the proboscis. The body is greatly depressed and the dorsal profile is only slightly arched.

So far as we are aware, *G. salweenica* is the first species of the genus to be described from the Salween River system.

Measurements in millimetres.

Total length excluding caudal	71·7	99·3
Depth of body	17·0	26·0
Length of head	14·8	25·5
Width of head	13·3	19·7
Height of head at occiput	11·6	18·0
Diameter of eye	3·0	4·0
Length of snout	8·0	13·8
Interorbital width	7·3	10·7
Length of pectoral	16·2	24·7
Length of ventral	14·9	23·0
Longest ray of dorsal	15·2	23·6
Longest ray of anal	12·7	21·5
Length of caudal peduncle	12·7	18·4
Least height of caudal peduncle	9·8	15·6

Garra gravelyi (Annandale)

1918. *Discognathus lamta*, Annandale (*nec* Hamilton), *Rec. Ind. Mus.*, XIV, p. 45.

1919. *Discognathus gravelyi*, Annandale, *Rec. Ind. Mus.*, XVI, p. 133, pl. ii, figs. 3, 3*a*.

1921. *Garra gravelyi*, Hora, *Rec. Ind. Mus.*, XXII, p. 654.

Five specimens, ranging in length from 63 mm. to 96 mm. without the caudal, were collected by the late Dr. N. Annandale in the Inlé Basin and referred by him to the composite species *G. lamta* Ham. Buch. He remarked at the time that one individual from the He-Ho stream " represents a distinct and apparently undescribed species." In the following year, Annandale described this specimen as a new species and remarked : " It is distinguished from *D. lamta* by the different shape and the larger size of its mental disk, by the different shape of the head, by its larger scales and apparently also by difference in the formulae of the fin-rays." In 1921, one of us pointed out that the differences noted by Annandale could be correlated with difference in the sexes of the specimens and referred all the specimens from the Inlé Basin to *G. gravelyi*. In Mr. Sondhi's collection, there are two large, male specimens which we refer to *G. gravelyi* and give below a table of measurements to show differences in proportions from the typical specimens which are of a much smaller size. Mr. Sondhi obtained his examples from a paddy field at Gaunphpo, Lawksawk State (Southern Shan States), which received its supply of water from a small, torrential stream Chaung Gyi.

[1] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 48, text-figs. 4, 5 (1934).

The males of *Garra gravelyi* are characterized by the possession of 4 barbels, by the eyes being situated wholly in the posterior half of the head, by the presence of an ill-defined proboscis without lateral lobes and by the fact that the last spine of the dorsal fin is longer than the head. The mental disk is of a large size in this species.

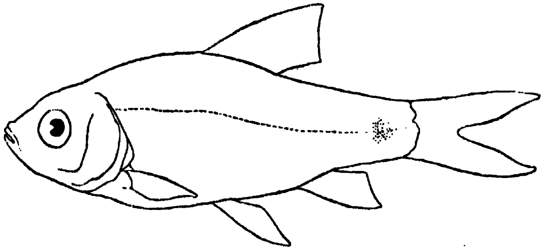
Measurements in millimetres.

Total length including caudal	142·0	146·0
Length of caudal	31·6	29·0
Depth of body	26·0	27·0
Length of head	24·0	24·5
Width of head	17·2	17·5
Height of head at occiput	18·2	18·0
Diameter of eye	5·2	6·0
Length of snout	12·0	12·0
Interorbital distance	10·8	10·2
Length of pectoral	25·5	25·0
Length of ventral	24·0	24·2
Longest ray of dorsal	25·0	26·0
Longest ray of anal	21·0	20·5
Length of caudal peduncle	20·0	22·5
Least height of caudal peduncle	13·5	14·5

Barbus puntio (Ham. Buch.) Day

1870. *Barbus (Puntius) puntio*, Day, *Proc. Zool. Soc. London*, p. 100.
1878. *Barbus puntio*, Day, *Fish. India*, p. 582, pl. cxlv, fig. 6.

In Mr. Sondhi's collection, there is a small specimen, 34 mm. in length excluding the caudal, which agrees in all essential respects with Day's descriptions of *Barbus puntio*; it was obtained from the Nam MeHsai stream in the Kēngtūng State.



TEXT-FIG. 6.—Lateral view of the Nam MeHsai specimen of *Barbus puntio* (Ham. Buch.) Day. × 2¼.

In the example under report, the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin. The last dorsal spine is smooth, osseous and entire though weak. The caudal fin is bifurcate and longer than the head. The length of the head is contained 3·5 times and the depth of the body 3·25 times in the total length without the caudal. The head is slightly longer than high.

The eyes are large and prominent; the diameter of the eye is contained 2·5 times in the length of the head, 0·5 times in the length of the snout and 0·75 times in the interorbital width. There are about 22 scales along the lateral line and 3 rows of scales below it to the base of the ventral fin. The lateral line is prominent on the first 9 to 10 scales and then it becomes indistinct or is absent. The colour is silvery, darker above and lighter below. There is a distinct black blotch at the base of the caudal; the dorsal and the anal fins are tipped with black. The body is covered with small, black spots which are packed more closely along the edges of the scales.

Under the name *Cyprinus puntio*, Hamilton [1] described a small species from the "ponds and ditches of the southern parts of Bengal," and a reference to his 'Original Notes' shows that the species was obtained by him at 'Luckipur' and Calcutta. Unfortunately it has never been taken from Bengal since Hamilton's time, and the original description is very meagre and inadequate. No illustration of the species exists in Hamilton's published or manuscript drawings. In the circumstances it is very difficult to be certain of the identity of Hamilton's *puntio* and the species must be regarded as a *species inquirendum*.

In 1870, Day redescribed Hamilton's *puntio* from 5 specimens obtained at "Sittoung" in Burma and remarked "I have redescribed the species, as its existence has been doubted, apparently not having been taken since Hamilton Buchanan's time." Day appears to have been influenced by the markings in front of the caudal fin and large scales in associating his Burmese examples with *puntio*. There is no other indication that the two forms are conspecific. For this reason we have indicated the authorship of the species as given above. In Day's figure of the species, the dorsal profile is shown as greatly arched, but this is not so in the specimen before us. Day's original of the figure preserved in the collection of the Indian Museum, is greatly damaged and it is not possible, therefore, to elucidate exactly the specific characters of his species.

Barbus terio is closely allied to Day's *puntio*, but the two species differ in certain body proportions, colouration and the extent of the lateral line.

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[1] Hamilton, *Fish. Ganges*, pp. 318, 319 (1822).

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STUDIES ON INDIAN ITONIDIDAE (CECIDOMYIDAE : DIPTERA).

By M. S. MANI, *Entomology Section, Zoological Survey of India, Indian Museum, Calcutta.*

(PLATE VII.)

CONTENTS.

INTRODUCTION.

The Itonididae, gall midges or gall gnats, generally known as the Cecidomyidae, are a very large family of small Nemocerate Diptera of world-wide distribution. They are well-known for the galls or similar deformities which they produce on various kinds of plants. The family comprises over three thousand species, distributed over four hundred genera of small, slender, soft-bodied flies, ranging in length from 0·5 mm. or even less to 8·0 mm., usually with broad wings and relatively long antennae. The tibiae are unarmed apically, the coxae are not produced and the wings usually have but three or four long veins. Except in the more generalised forms, ocelli are absent. They are closely related to the family Mycetophilidae, from which they are distinguished by the shorter coxae, the absence of apical tibial spurs and fewer veins in the wings. From the other allied families, Culicidae and Chironomidae, of the Nemocerate Diptera, they differ in not having aquatic larvae, in the unscaled wing veins and in the non-plumose male antennae.

They lay eggs on various kinds of plants and the minute apodous larvae hatching from them attack vegetable tissues resulting in the

formation of excrescences or galls. The larvae derive both shelter and nourishment from the vegetable tissues and except in some genera most of them pupate in the gall itself. A considerable number of midges, however, do not produce galls on plants and many more live on decaying vegetable matter. Several species are also known to be zoophagous, attacking other gall midges, mites, scale-insects, plant-lice, Psyllids, etc.

Several of the gall midges are of great economic importance and include both beneficial and injurious species. Some seed-infesting forms are materially useful in checking the spread of undesirable or injurious plants on cultivated lands (127). *Asphondylia opuntiae* Felt, for instance, has in America completely eradicated a species of *Cactus*, a serious pest of agricultural lands in many parts of the world. Another notorious pest of America, the Canada Thistle, has also been eradicated by the midge, *Dasyneura gibsoni* Felt. Among the injurious species, the Hessian Fly, *Phytophaga destructor* Say, is a very serious pest. It is stated that the estimated loss, due to this fly, in wheat cultivation in New York State, was $3,000,000 in a single year. Pear midge, clover midge, rose midge, willow midge, chrysanthemum midge and many others are also serious pests of numerous cultivated plants in Europe and America. The Paddy silver-shoot gall midge has often caused considerable damage in rice plantations in many parts of South India. The damage in kitchen gardens due to the Bitter-gourd vine gall fly, *Lasioptera falcata* Felt, is sometimes very great. Their zoophagous habits, however, make them at times a friend of the agriculturist, as they attack and effectively check the spread of the injurious aphids, scale-insects, etc., on which they feed.

Gall midges have been known from very early times. Pliny, Malpighi and Reaumer seem to have been acquainted with them. Linnaeus and De Geer described them as *Tipula*. Fabricius classed them as *Chironomus*. It was only in 1800, when Meigen (129) published his *Nouvelle Classification des mouches a deaux ailes* (Diptera L.) *d' apres un plan tout nouveau*, and erected the genus *Itonida* Meig., that their true position was made known. Three years later Meigen (130) published diagnoses of a number of genera already described in 1800 but gave new names to almost all of them. In this work the genus *Cecidomyia* Meig. was erected and the name Cecidomyidae proposed for the family, with *Tipula pini* D. G. as the genotype. For years there was disagreement as to the exact position of *Cecidomyia* Meig. and in 1850 Loew (120), to avoid confusion, proposed the generic name *Diplosis* H. Loew. In the year 1805 Latreille (115) created the genus *Oligotrophus* Lat. In 1818, Meigen (131) erected the genus *Lasioptera* Meig. Rondani (147) divided the family into the sub-families Lestremiinae and Cecidomyinae. In 1908, Hendel (84) republished the " Nouvelle Classification " of Meigen (129) and suggested that as the descriptions corresponded more or less closely with those in Meigen's 1803 paper (130), the earlier set of names should be given priority over those of 1803 in general use. The decision of the International Commission on Zoological Nomenclature also agreeing with this view, the name *Cecidomyia* Meig. was replaced by the earlier *Itonida* Meig. Since then a satisfactory classification has been worked out by such well-known specialists as Rubsaamen, Kieffer and Felt. In addition

to describing numerous new genera and species from Europe, Kieffer (111) also published in 1913 his well-known monograph of Cecidomyidae in the *Genera Insectorum* series. The gall midges of America have been made known chiefly through the descriptions of Felt. His studies have also enriched our knowledge of the morphology and biology, while his *Key to Gall midges* (76) published in 1925, has placed the taxonomy of this group on a sound basis.

Occasional descriptions of gall midges of India were published from time to time in periodicals, several of which are not easily accessible. Brunetti (12) published a list of all Indian gall midges known up to 1920, and later Senior-White (167) collected together all references to the gall midges described from this country. The first gall midge to be described from India, *Lasioptera bryoniae* Schin., was by Schiner (165), while the well-known silver-shoot gall midge of Paddy was recorded by Wood-Mason (187) a few years later under the name *Cecidomyia oryzae*[1]. Kieffer (103) described some Bengal species in 1905, and later a number of midges from other parts of India (105). He (109) has also described a few species from Ceylon. Ramachandra Rao made extensive collections of these insects and made valuable observations (140) on the food-habits of numerous grass-infesting midges. One Indian fossil gall midge, *Winnertzia burmitica* (Cockl.)[2], was described by Cockerell (13) from burmite deposits. Houard (85) and Van Leeuwen (177 and 178) also described some midge galls from India. Sundar Raman (168) published a summary of the available information on the midge galls described from India. Felt's recent contributions on the Indian species of this family are the most important, and in all about one hundred species distributed over forty eight genera have so far been recorded from India. The rich flora of India, however, supports a much larger number of gall midges.

I began my studies on this group in 1926 and made extensive collections in various parts of India, particularly in South India. A considerable portion of the material studied was bred from various plant galls, though many midges were captured while on flight. Through the courtesy of the various authorities concerned, I have been able to examine the collections in the Agricultural Research Institute, Coimbatore and the Central Agricultural College and Research Institute, Pusa. Numerous unidentified midges collected at various times by the late Dr. N. Annandale, Dr. Stanley Kemp and the other officers of the Zoological Survey of India, were also placed at my disposal through the kindness of Dr. Baini Prashad, Director, Zoological Survey of India. A number of midges were also received from various other sources by presentations and exchanges.

As a result of these studies I have come across several new genera and species and the following well-known genera not previously recorded from this country: *Catocha* Hal., *Microcerata* Felt, *Clinophena* Kieff., *Neolasioptera* Felt, *Prolasioptera* Kieff., *Stefaniola* Kieff, *Thurauia* Rubs., *Myricomyia* Kieff., *Microdiplosis* Tav., *Cecidomyiella* D. G. and *Xylodiplosis* Kieff. Two new genera and nineteen new species are described

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[1] This midge was referred by Felt (72) to the genus *Pachydiplosis* Kieff., but has never been described. I have described it in detail in this paper p. 433.

[2] Originally described as *Winnertziola burmitica* Cockl. *vide infra* p. 384.

below. The arrangement of the sub-families, tribes and genera is based on the classification proposed by Felt (76). In the matter of nomenclature, the decisions of the International Commission have been strictly adhered to and Meigen's earlier name of 1800 is used. Notes on the habits and life-history of the midges are also given in a few cases. The galls made by the various new species of midges are also described in detail. The elaborate keys of Felt to the genera and species, revised wherever necessary to include the new forms which are given in this paper, will, it is hoped, be found useful by future workers on this difficult group. The types of the new genera and species described here are deposited in the collections of the Zoological Survey of India, Indian Museum, Calcutta.

I take this opportunity of recording my great indebtedness to the world-authority on this family, Dr. E. P. Felt, State Entomologist, New York, whose works have been indispensible throughout my studies. My grateful thanks are due to Dr. Baini Prashad, Director, and to Dr. Hem Singh Pruthi, formerly Assistant Superintendent, Zoological Survey of India, for giving me all facilities for work, for valuable suggestions and for constant encouragement and help. My sincere thanks are also due to Rao Bahadur Y. Ramachandra Rao, Locust Entomologist, Karachi, for guiding me in the early stages of my study. Last but not the least, my thanks are also due to Dr. Ronald Senior-White, Malariologist, Bengal Nagpur Railway, Calcutta, for helping me with important literature.

SYSTEMATIC.

The family Itonididae is divided into three sub-families, *viz.*, Lestremiinae, Heteropezinae and Itonididinae.[1] The sub-family Lestremiinae is the most generalised group of this family, being the connecting link between the families Itonididae and Mycetophilidae. In its general characters and habits, it is not far removed from the Mycetophilidae, but it is easily distinguished by the absence of apical tibial spurs and by the moderate development of the coxae. The members of this subfamily are mostly small or medium-sized, dark brown or black midges, and are characterised by the metatarsus being longer than the following segments, by the presence of the long forked or simple fourth vein and by the entire absence of circumfili. Most midges belonging to this group breed, like the Mycetophilidae, in dead or decaying vegetable matter. There are two tribes under this sub-family : Lestremiinariae and Campylomyzariae. The tribe Lestremiinariae, comprising eight genera, is characterised by a forked fourth vein. The other tribe Campylomyzariae is recognised by a simple fourth vein and includes twenty three genera ; it is more specialised than the Lestremiinariae.

[1] Some authors recognise a fourth sub-family, Termitomastinae. This sub-family is rather decadent and its exact relation to the other sub-families is not clearly understood. It includes the genus *Termitomastus* Silvestri, which consists of rather peuliar, nearly apterous midges, exclusively found as guests in the nests of termites. The sub-family differs from all others in the very much atrophied wings, two long and *two cross-veins* ; in the enormously swollen first five abdominal segments and in the small, slender posterior four abdominal segments. It is apparently confined to the Neotropical Region of South America.

The sub-family Heteropezinae is a connecting link between the two other sub-families, and according to Felt, is one of the oldest and most decadent group of midges. In general, it resembles Lestremiinae but is readily distinguished by the metatarsus being longer or shorter than the following segments, by the wings having not more than three long veins and by the absence of a cross-vein connecting the third vein with the sub-costa. There are about seventeen genera in this group. No form of this sub-family has yet been found in India.

The remaining sub-family Itonididinae is much larger than either of the preceding two and includes a great number of midges. The members of this sub-family are recognised by the metatarsus being always shorter than the following segment and by the presence of circumfili. It is divided into six tribes: Porricondylariae, Lasiopterariae, Dasyneurariae, Oligotrophiariae, Asphondylariae and Itonididinariae.

The tribe Porricondylariae is related to the tribe Lestremiinariae of the sub-family Lestremiinae, but is easily recognised by a distinct cross-vein connecting the third vein with the sub-costa. It comprises thirty genera, of which eight have been found in India. Most of the species breed in decaying vegetable matter, although many attack living plants and produce galls on them.

The tribe Lasiopterariae includes a large number of well-marked gall-forming midges, distributed over eighteen genera, three of which occur in India. The members of this tribe are recognised by the great reduction of the costa and the more or less close approximation of the costa, the sub-costa and the third vein. These three veins are also thickly scaled. The abdomen is often thickly covered with black and silvery-white or yellowish scales. The antennae are short and have numerous short, sessile, cylindrical segments.

The next tribe, Dasyneurariae, comprises over forty-two genera, distributed all over the principal continents. Four genera have been found in India. The midges of this tribe are separated from all others by their denticulate claws, by the third vein being well separated from the costa and by the antennal segments being produced and often stemmed. They breed in wrinkled leaves, buds, and leaf galls.

The Oligotrophiariae are distinguished from the foregoing tribe by their simple claws. They include twenty-eight genera, of which only two have been found so far in this country. The genera of this tribe were originally included by Kieffer and Rubsaamen in the Dasyneurariae but Felt has rightly separated them.

The tribe Asphondylariae is widely distributed and comprises large-sized midges, distributed over twenty-seven genera, three being known from India. The midges of this tribe are recognised by the sessile, elongate, cylindrical antennal segments, simple claws and the usually aciculate ovipositor. They are all gall-forming in habit and mostly attack leaves and flowers but sometimes fruits as well.

The remaining tribe Itonididinariae is the most specialised group and is the richest in genera and species. It includes more than half the known genera and about one-third of the known species. It is subdivided into two sub-tribes: Bifila and Trifila. Thirty-two Indian genera fall under this group. The species belonging to it are characterised

by the greatly produced binodose male antennal segments, and the circumfila formed into bow-like loops. The sub-tribe Bifila has the nodes of the male antennal segments equal and with only two whorls of circumfila on the enlargements. The sub-tribe Trifila differs in having the nodes distinctly unequal and with three whorls of circumfila. Most midges included in this tribe are gall-forming, while many are mycophagous or zoophagous. A key to the sub-families and tribes from Felt is given below, while for the genera reference may be made to Felt (76).

Key to sub-families and tribes.

I. Metatarsus longer than the following segment, tarsal segments five; wings with four long veins, cross-vein usually present	Lestremiinae.
A. Fourth vein forked	Lestremiinariae.
B. Fourth vein simple, not forked . . .	Campylomyzariae.
II. Metatarsus longer or shorter than the following segment; wings with not more than three long veins, cross-vein absent; circumfila wanting . . .	Heteropezinae.
III. Metatarsus always shorter than the following segment; wings with three or four long veins; circumfila present	Itonididinae.
A. Wings with a distinct cross-vein connecting third vein and sub-costa and usually parallel with costa	Porricondylariae.
B. Wings without a distinct cross-vein.[1]	
1. Costa thickly scaled, third vein usually very close to the anterior margin of the wing; antennal segments cylindrical, sessile and not produced	Lasiopterariae.
2. Costa rarely thickly scaled, third vein well separated from costa; antennal segments produced	
a. Flagellate antennal segments cylindrical, never binodose in the male.	
i. Claws toothed	Dasyneurariae.
ii. Claws simple.	
A. Flagellate antennal segments cylindrical, not greatly elongated, usually stemmed in the male; ovipositor not aciculate	Oligotrophiariae.
B. Flagellate antennal segments cylindrical, elongated, sessile; ovipositor usually aciculate .	Asphondylariae.
b. Flagellate antennal segments of male greatly produced, binodose; circumfila usually formed into bow-like loops .	Itonididinariae.
i. Nodes of the male flagellate antennal segments equal, circumfila two	Bifila.
ii. Nodes of the male flagellate antennal segments distinctly unequal, circumfila three . . .	Trifila.

[1] Except in some genera of the Itonididinariae, the cross-vein is generally absent. These genera are included by Felt (76) both under Porricondylariae and Itonididinariae, in the latter tribe on account of the antennal structure. I am, however, inclined to bring together under the Porricondylariae all genera with a cross-vein, which I believe is of greater phylogenetic importance than the antennal structure. Felt's table of Itonididinariae needs revision.

Sub-family LESTREMIINAE.

Tribe LESTREMIINARIAE.

Genus **Catocha** Hal.

1833. *Catocha*, Haliday, *Entomol. Mag. London*, I, p. 156.
1846. *Macrostyla*, Winnertz, *Stett. Entomol. Zeit.*, VII, p. 20.
1846. *Furcinerva*, Rondani, *Nuov. Ann. Sc. Nat. Bologna*, (2) V, p. 7.
1862. *Catocha*, Osten Sacken, *Mon. N. Amer. Dipt.*, I, p. 177.
1864. *Catocha*, Schiner, *Fauna Austriaca, Dipt.*, II, p. 412.
1895. *Catocha*, Kieffer, *Bull. Soc. Entomol. France*, p. 319.
1900. *Furcinerva*, Kieffer, *Ann. Soc. Entomol. France*, LXIX, pp. 438-440.
1908. *Catocha*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 308.
1913. *Catocha*, Felt, *Bull. N. Y. St. Mus.*, No. 165, pp. 129-131.
1913. *Catocha*, Kieffer, *Gen. Ins.*, fas. 152, p. 306.
1925. *Catocha*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 136.

This genus, with about a dozen species mostly from America, has not so far been recorded from India. Some species occur on mosses; but no information is available about their habits and life-history.

The species of this genus are readily distinguished by the antennae having 11-16 segments, with the second segment not greatly enlarged and sometimes with several whorls of hairs on the segments. The palpi are quadriarticulate. Costa extends beyond the apex of the wing where it is joined by third vein.

Genotype.—*Catocha latipes* Hal.

Key to species, revised from Felt.

I. Flagellate antennal segments uninodose.
  A. Pulvilli rudimentary.
    1. Second, third and fourth palpal segments sub-equal . . . . . . *C. barberi* Felt.
    2. Second, third and fourth palpal segments unequal . . . . . . *C. indica*, sp. nov.
  B. Pulvilli well-developed . . . . . . *C. slossonae* Felt.
II. Flagellate antennal segments binodose . . . . *C. americana* Felt.

Catocha indica, sp. nov.

This new species appears to be closely allied to the American *Catocha barberi* Felt, but differs in the distal three palpal segments being of unequal length.

Female.— 3 mm. long. Antennae about one-fourth the length of the body, thickly haired, dark brown, segments 16; flagellate segments uninodose, fifth antennal segment of a length about twice its diameter, ninth and tenth segments barrel-shaped, eleventh segment with a stem one-fourth the length of the cylindrical basal enlargement, terminal segment fusiform, stout, of a length a little over twice its diameter. First palpal segment short, stout; second segment one and a half times stouter than the third, the latter a little more than twice its diameter. Mesonotum black. Scutellum and post-scutellum black. Abdomen dark brown. Basal plate of lamellae of ovipositor sub-quadrate, with a length nearly equal to its width; terminal plate elliptic, a little over half the breadth of the basal plate and a little over twice as long as broad. Metatarsus nearly as long as all the succeeding segments.

Co-types.—Females on slide Nos. $\frac{972}{H\,6}$ and $\frac{973}{H\,6}$.

Type-locality.—Lutkoh Valley, Chitral, N.-W. F. Provinces. Coll. Dr. B. N. Chopra, at light.

Genus **Lestremia** Macq.

1826. *Lestremia*, Macquart, *Rec. Soc. Sc. Ag. Lille*, p. 173.
1826. *Lestremia*, Meigen, *Syst. Beschr.*, V, p. 308.
1840. *Mimosciara*, Rondani, *Mem. In. Ital. Sc. Nat. Milano*, (4) II, p. 287.
1844. *Cecidogona*, Herman Loew, *Stett. Entomol. Zeit.*, V, p. 324.
1846. *Mimosciara*, Rondani, *Nuov. Ann. Soc. Nat. Bologna*, (2) VI, p. 10.
1846. *Furcinerva*, Rondani, *Nuov. Ann. Soc. Nat. Bologna*, (2) VI, p. 369.
1856. *Yposatea*, Rondani, *Dipt. Ital. Prodr.*, I, p. 198.
1860. *Molobroea*, Rondani, *Atti Soc. Sc. Nat. Lest. Milano*, II, p. 287.
1862. *Lestremia*, Osten Sacken, *Mon. N. Amer. Dipt.*, I, p. 178.
1864. *Lestremia*, Schiner, *Fauna Austriaca, Dipt.*, II, p. 413.
1870. *Lestremia*, Winnertz, *Verh. zool-bot. Ges. Wien.*, XX, p. 30.
1897. *Lestremia*, Kieffer, *Syn. Cecid. Europ. Alg.*, p. 52.
1900. *Mimosciara*, Kieffer, *Ann. Soc. Entomol. France*, LXIX, p. 437.
1900. *Cecidogona*, Kieffer, *Ann. Soc. Entomol. France*, LXIX, p. 443.
1900. *Furcinerva*, Kieffer, *Ann. Soc. Entomol. France*, LXIX, p. 443.
1908. *Lestremia*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 31.
1913. *Lestremia*, Felt, *Bull. N. Y. St. Mus.*, No. 165, p. 133.
1913. *Lestremia*, Kieffer, *Gen. Ins.*, fas. 152, p. 307.
1920. *Lestremia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1925. *Lestremia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 136.
1928. *Lestremia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 10.

This is the most generalised genus of the family. It has a world-wide distribution. About thirty species, most of them from America, have been recorded so far. Some European forms have been bred from decaying wood, but no information is available regarding the habits and life-history of the others. Two Indian species were described by Kieffer.

This genus is closely related to the genus *Catocha* Hal., but differs in the costa not extending beyond the apex of the wing. It is readily recognised by the following characters: Palpi quadriarticulate. Antennal segments 11-16, the second segment not greatly enlarged, third and fourth segments not fused, short, sub-cylindrical or sub-conical in the female; the male antennal segments with a distinct stem, the basal enlargements with crenulate whorls and long curved setae. Costa does not extend beyond the apex of wing before which it is joined by third vein. Fourth vein is forked.

Genotype.—*Lestremia cineria* Macq.

Key to species.

I. Terminal plate of lamellae of ovipositor lengthened, twice as long as broad; body yellowish in colour .	*L. indica* Kieff.
II. Terminal plate of lamellae of ovipositor short, sub-orbicular; body reddish in colour	*L. ceylanica* Kieff.

Lestremia indica Kieff.

1909. *Lestremia indica*, Kieffer, *Rec. Ind. Mus.*, III, p. 29, fig. 1.
1913. *Lestremia indica*, Kieffer, *Gen. Ins.*, fas., 152, p. 308.
1920. *Lestremia indica*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 18.
1928. *Lestremia indica*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 10.

This species was described from midges collected by Dr. Annandale in Calcutta. The wing is figured by Kieffer. The type is in the Indian

Museum. Gravely observed it at Kurseong, Eastern Himalayas. One female was captured at light in Howrah. It appears to breed in decaying leaves. The adults avoid strong day light and hide in crevices in the bark of shady trees.

Lestremia ceylanica Kieff.

1912. *Lestremia ceylanica*, Kieffer, *Spol. Zeyl.*, VIII, p. 29.
1920. *Lestremia ceylanica*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 18.
1928. *Lestremia ceylanica*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 19.

This species was described from a female taken at light in Peradeniya, Ceylon. The type is lost due to bad preservation. One female was collected at light in a railway train at Trichinopoly, South India, which I readily identified as this species. Apparently it is distributed throughout South India. The species is not recorded by Kieffer in *Genera Insectorum*. The midges of this species are smaller than those of *L. indica* Kieff. and are of reddish colour.

Genus **Neolestremia,** nov.

This new genus is erected for midges bred from the leaf bud galls of *Boerhaavia* spp. It approaches *Lestremia* Macq. very closely, but is chiefly distinguished from it by its triarticulate palpi.

The following additional characters should prove useful for the identification of the genus. Antennae with 16 segments in the female, the first two flagellate segments not fused, second segment not greatly enlarged, all segments sub-cylindrical, uniformly covered with short setae and with stems never produced. Costa not reaching the apex of the wing but nearly disappearing at its union with third vein as in the genus *Lestremia* Macq., which it resembles in all other characters. The midges are also relatively larger.

Genotype.—Neolestremia boerhaaviae, sp. nov.

To indicate the exact relationships of the new genus *Neolestremia* with the allied genera I give below a revised version of Felt's Key (76), to the genera in which the antennae are moderately developed, having at least 11-16 segments, and with the second segment not greatly enlarged.

A. Palpi quadriarticulate.
  1. Costa extending beyond apex of wing . . *Catocha* Hal.
  2. Costa not reaching apex of wing but nearly disappearing at its union with third vein . *Lestremia* Macq.
B. Palpi triarticulate.
  Costa not reaching apex of wing but nearly disappearing at its union with third vein . . . . *Neolestremia*, gen. nov.

Neolestremia boerhaaviae, sp. nov.

Female.— 3·5 mm. long. Body brownish in colour. Antennae one-third the length of body; segments 16; stems of flagellate segments grow longer towards the distal part of antennae, first antennal segment irregular, second segment globose, both with lengths a little greater than their diameters, third segment with a length over twice its daimeter, with a stem roughly one-sixth the length of the enlargement, fifth segment with a length about twice its diameter and with a stem one-fourteenth the length of enlargement, twelfth segment with a length

twice its diameter and with a stem one-sixth the length of enlargement, terminal segment longer than all the preceding, somewhat reduced towards the apex and with a length about four times its basal diameter. Palpi first segment sub-globose, stout; second segment roughly obovate-elliptic, with a length about twice its diameter and a little over four times the first segment and somewhat more slender; third segment more slender than the second, sub-cylindrical, basally narrowed somewhat, with a length a little over four times its diameter. Metatarsus of fore-legs as long as all the next three other segments, metatarsus of mid-legs longer than the next three segments and the metatarsus of hind-legs longer than all the other segments and also nearly two-thirds longer than the metatarsi of the mid and fore-legs. Claws simple. Pulvilli short but longer than half the length of claws in the fore-legs and much shorter than half its length in the other legs. Basal segment of lamellae of ovipositor roughly quadrilateral, with somewhat rounded sides, and a little longer than twice its breadth. Terminal segment as long as the basal segment, linear-elliptic and one-third narrower than the basal segment.

Holotype.—Male, on slide No. $\frac{975}{\text{H 6}}$.

Type-locality.—Madras Medical College Grounds, Madras Presidency, South India. Coll. M. S. Mani, 11.xi.1929.

Habitat.—Leaf bud galls of *Boerhaavia* spp. (Nyctagenae).

Life-history.—The eggs are laid on the tender buds and minute, colourless, apodous maggots hatch from them on the second day. The larvae attack the buds, the further development of which is thus interfered and instead of normally opening turn into a gall[1]. They feed on the viscid juice exuding from the glandular hairs and develop for nine days, at the end of which they are 3 mm. long and yellowish in colour. They then migrate from the galls and wander on the surface of the plant for a time and drop to the soil where they pupate. Pupal period occupies four days, at the end of which the adults fly out. There are several generations in one year. They also seem to hibernate in the soil during the hot summer months.

Genus **Microcerata** Felt.

1908. *Microcerata*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 309.
1911. *Microcerata*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 32.
1913. *Microcerata*, Kieffer, *Gen. Ins.*, fas. 152, p. 309.
1925. *Microcerata*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 136.

This genus has not been previously recorded from India. It is characterised by the great reduction of the antennae, which have only 8-10 or 11 segments. The species of this genus are believed to breed in decaying vegetable matter.

The genus may be recognised by the following characters: Palpi tri- or quadriarticulate; second antennal segment sub-globose and greatly enlarged; flagellate segments gradually grow shorter towards

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[1] I am not quite sure whether this midge really causes gall-formation in this case as it is apparently the first record of such a habit. It appears probable that some other agency, possibly another midge, is the true gall-maker and *Neolestremia boerhaaviae*, sp. nov. may be an inquiline. I record here only the life-history, and the exact rôle of the species remains to be determined by future observations.

the distal part of the antennae; sub-costa and third vein united as though by a very short cross-vein, the fork of the fourth vein even; claws simple or denticulate.

Genotype.—Microcerata perplexa Felt.

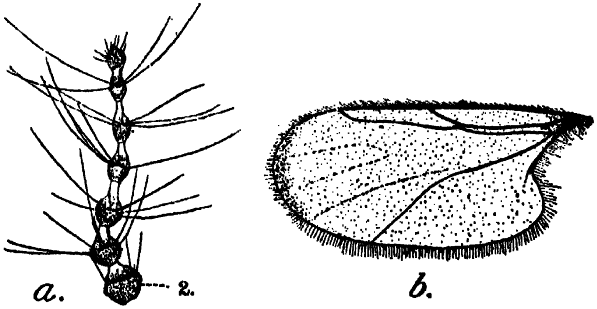
Key to species, revised after Felt..

I. Antennal segments 8.	
A. Claws simple	*M. cockerelli* Felt.
B. Claws denticulate.	
1. Palpi triarticulate	*M. indica*, sp. nov.
2. Palpi quadriarticulate	*M. johnsoni* Felt.
II. Antennal segments 9.	
A. Palpi triarticulate	*M. diervilli* Felt.
B. Palpi quadriarticulate.	
1. First three palpal segments sub-equal, fourth segment twice the length of the third	*M. corni* Felt.
2. First two palpal segments sub-equal, third segment one half longer, fourth segment twice the length of third . .	*M. spinosa* Felt.
III. Antennal segments 10.	
A. Pulvilli shorter than claws	*M. perplexa* Felt.
B. Pulvilli as long as claws	*M. borealis* Felt.
IV. Antennal segments 11	*M. texana* Felt.

Microcerata indica, sp. nov.

(Text-figs. 1 & 2.)

Male.— 1 mm. long. Body reddish-brown in colour. Antennal segments 8, first two segments reddish-brown, flagellate segments fuscous,



TEXT-FIG 1.—*Microcerata indica*, sp. nov. *a.* antennae of male showing the segments becoming gradually smaller and shorter (Highly magnified); *b.* wing showing the third vein united with sub-costa as though by a very short cross-vein.

second antennal segment with a stem one-sixth the length of the basal enlargement, fourth segment with a stem one half the length of the basal

enlargement, terminal segment somewhat stouter than the one immediately preceding. Palpi triarticulate, first segment stout and expanded apically, second and third segments sub-equal and nearly half the length of the first. Mesonotum brownish-black. Wings coloured brown towards the apex. Claws tridentate. Empodium one half the length of claws.

TEXT-FIG 2.—*Microcerata indica*, sp. nov. Fifth tarsal segment with denticulate claws and empodium. (Highly magnified.)

Co-types.—Males, partly dissected on two slides. Nos. $\frac{976}{H\,6}$ and $\frac{977}{H\,6}$.

Paratypes.—Dry on pins. No. $\frac{978}{H\,6}$.

Type-locality.—Medha, Yenna Valley, Satara District, Bombay Presidency, 2000 ft. Coll. F. H. Gravely, 17-23. iv.1912.

Tribe CAMPYLOMYZARIAE.

Genus **Peromyia** Kieff.

1894. *Peromyia*, Kieffer, *Bull. Soc. Entomol. France*, p. 63.
1911. *Peromyia*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 32.
1912. *Peromyia*, Felt, *Bull. N. Y. St. Mus.*, No. 165, p. 160.
1913. *Peromyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 292.
1920. *Peromyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1925. *Peromyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 137.
1928. *Peromyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 19.

This genus appears to be identical with *Neurolyga* Rond. It seems to be insufficiently defined and appears in two places in Felt's (76) key to genera : between *Projoanissia* Kieff. and *Trichopteromyia* Will., and again between *Tetraxyphus* Kieff. and *Micromyia* Kieff. Two species, including one from India, have been described so far.

The following diagnosis of Felt will help in the identification of this genus : Palpi biarticulate ; antennal segments 13 in female and 14, sub-globose and long-stemmed in male ; third vein curves distally and joins the margin of the wing near the rudimentary fourth vein ; claws sharply bent at right angles and swollen at the apical third ; pulvilli long ; basal clasp segment stout and truncate ; terminal clasp segment short, stout, curved apically, greatly swollen and obtusely rounded distally ; ovipositor quadriarticulate.

Genotype.—*Peromyia leveillei* Kieff.

Peromyia bengalensis Kieff.

1905. *Peromyia bengalensis*, Kieffer, *Ann. Soc. Sc. Bruxelles*, XXIX, p. 158.
1913. *Peromyia bengalensis*, Kieffer, *Gen. Ins.* fas. 152, p. 292.
1920. *Peromyia bengalensis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1928. *Peromyia bengalensis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 19.

This species was bred along with *Daphnephila lindrae* Kieff. (*vide infra* p. 415) from the galls of the latter, in which it appears to be an inquiline. The type could not be traced.

It may be recognised by the following characters: 1·5 mm. long.; reddish in colour; third antennal segment with a length twice its diameter; claws simple, twice as long as the empodium.

Sub-family ITONIDIDINAE.

Tribe PORRICONDYLARIAE.

Genus **Winnertzia** Rond.

1834. *Cecidomyia* (*partim*), Bouche, *Naturgesch. Insekten.*, I, p. 27.
1853. *Asynapta* (*partim*), Winnertz, *Linn. Entomol. Stett.*, VIII, p. 305.
1860. *Winnertzia*, Rondani, *Atti. Soc. Ital. Sc. Nat. Milano*, II, p. 287.
1864. *Clinorhiza*, Kieffer, *Ann. Soc. Entomol. France*, LXIII, p. 340.
1908. *Winnertzia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, pp. 415, 421-422.
1913. *Winnertzia*, Kieffer, *Gen. Ins.*, fas. 152, p. 281.
1913. *Winnertziola*, Kieffer, *Marcellia*, II, p. 235.
1913. *Winnertziola*, Kieffer, *Gen. Ins.*, fas. 152, p. 283.
1915. *Winnertziola*, Felt, *Bull. N. Y. St. Mus.*, No. 180, p. 130.
1925. *Winnertzia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 139.

This genus, not previously recorded from this country, includes about thirty living and a few fossil species. It may be recognised by the cross-vein rising from third vein at an obtuse angle and by the horse-shoe shaped circumfila on opposite faces of the antennal enlargements. Fifth vein of wing is well developed.

Genotype.—*Winnertzia lugubris* Rond. (By original designation.)

Winnertzia burmitica (Cockerell).

1917. *Winnertziola burmitica*, Cockerell, *Psyche*, XXIV, p. 200, figs.

This fossil species was described by Cockerell from Burmese Amber, under the name *Winnertziola burmitica* Cockl. Felt (57) considers *Winnertziola* Kieff. to be identical with *Winnertzia* Rond. My own study of the diagnoses of the two genera has confirmed this view.

This species was found in clay of Miocene age, but Cockerell believes it to be older. The type location is not cited but it is presumably in the British Museum. Palpus, basal part of antenna, wing, part of haltere, claw and genitalia of this fossil are figured by Cockerell. Fletcher (80) has included this species in his account of Indian fossil insects and has reproduced the figures of Cockerell. Senior-White (167) has overlooked the genus in his Catalogue of Insects.

Genus **Colpodia** Winn.

1853. *Colpodia*, Winnertz, *Linn. Entomol. Stett.*, VIII, p. 188.
1908. *Colpodia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 416.
1913. *Colpodia*, Kieffer, *Gen. Ins.*, fas. 152, p. 268.
1920. *Colpodia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1925. *Colpodia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 140.
1928. *Colpodia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 17.

This genus comprises about twenty species, mostly American. It is remarkable for its rather long wings and is easily recognised by the following characters : antennae with 12-16 segments ; wings long and narrow, cross-vein at right angles to costa, fifth vein forked, sixth vein branches off from the fifth; claws usually simple; lamellae of ovipositor oval and feebly protractile; terminal clasp-segment short and swollen.

C. fletcheri Felt (59) was described from India. It falls between the American species *C. pratensis* Felt and *C. maculata* Felt in Felt's key (29) to species.

Genotype.—Colpodia angustipennis Winn. (By original designation).

Genus **Clinophena** Kieff.

1911. *Clinophena*, Kieffer, *Trans. Linn. Soc. London*, (2) Zool., XIV, p. 328.
1911. *Holoneurus* (partim), Kieffer, *Trans. Linn. Soc. London*, (2) Zool., XIV, p. 328.
1913. *Clinophena*, Kieffer, *Gen. Ins.*, fas. 152, p. 268.
1925. *Clinophena*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 140.

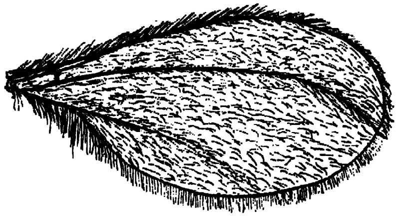
This small genus, with only one species, has not been previously recorded from India. It falls between *Colpodia* Winn. and *Paleocolpodia* Meun. in Felt's key (76) to genera. It resembles *Colpodia* Winn. in all characters except in the simple fifth vein not reaching the wing margin. It may be recognised by its long and narrow wings, with cross vein at right angles to costa and by its simple claws.

Genotype.—Clinophena mahensis Kieff.

Clinophena indica, sp. nov.

(Text-fig. 3.)

This new species is described from a male collected in the Eastern Himalayas.



TEXT-FIG 3.—*Clinophena indica*, sp. nov. Wing showing the fifth vein not reaching the posterior margin.

Male.— 1·5 mm. long. Antennae as long as body, segments 14; first six segments swollen somewhat basally and apically, rest of the

segments uniformly sub-cylindrical; third segment with a stem one half the length of basal enlargement, which latter has a length about six times its middle diameter; fifth segment with a stem two-thirds the length of the basal enlargement, which latter has the apical swelling a little stouter than the basal; eighth and ninth segments sub-equal, with stems also sub-equal in length to the basal enlargements, which latter have lengths a little over one quarter their diameters; terminal segment cylindrical, elongated, with a length about four times its diameter and with a constriction near its apex. Palpi first segment with a length twice its diameter; second segment thrice the length of the first and somewhat more slender; third segment one-third shorter than the second and stouter than all the other segments; fourth sub-equal to third but somewhat more slender; mouth parts somewhat prolonged. Claws simple, short, almost bent at right angles. Pulvilli a little over half the length of the claws.

Holotype.—Male, partly dissected on slide. No. $\frac{979}{H6}$.

Type-locality.—Kurseong, Eastern Himalayas, 4700 ft. to 5000 ft. Coll. N. Annandale, 20.vi.1910.

Genus **Misocosmus** Kieff.

1912. *Epidosis (partim)*, Kieffer, *Spol. Zeyl.*, VII, p. 29.
1913. *Misocosmus*, Kieffer, *Bull. Soc. Nat. Hist. Metz.*, XXVIII, p. 55.
1913. *Misocosmus*, Kieffer, *Gen. Ins.*, fas. 152, p. 276.
1920. *Misocosmus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1925. *Misocosmus*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 141.
1928. *Misocosmus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This genus may be recognised by the following characters: palpi quadriarticulate; antennal segments 13; flagellate segments of male elongated and distinctly stemmed, with circumfila not produced into long bow-like loops; flagellate segments of female sessile; wings with three long veins, crossvein parallel with costa, fifth vein forked; claws simple, very small; pulvilli rudimentary; lobes of ovipositor very small.

Genotype.—*Misocosmus ceylanicus* (Kieff.).

Misocosmus ceylanicus (Kieff.).

1912. *Epidosis ceylanicus*, Kieffer, *Spol. Zeyl.*, VIII, p. 29.
1913. *Misocosmus ceylanicus*, Kieffer, *Gen. Ins.*, fas. 152, p. 276.
1920. *Misocosmus ceylanicus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 17.
1928. *Misocosmus ceylanicus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This species was originally referred to the genus *Epidosis* H. Loew and was described from midges collected at Peradeniya, Ceylon. It was later made the genotype of *Misocosmus* Kieff. Brunetti records that the type is in the Indian Museum, but only the labels are left and the insects are no longer available.

Genus **Dicroneurus** Kieff.

1894. *Epidosis (partim)*, Kieffer, *Ann. Soc. Entomol. France*, LXIV, p. 320.
1895. *Dicroneurus*, Kieffer, *Entomol. Nachr. Berlin*, XXI, p. 122.
1913. *Dicroneurus*, Kieffer, *Gen. Ins.*, fas. 152, p. 270.
1920. *Dicroneurus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Dicroneurus*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 141.
1928. *Dicroneurus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This genus is related to the preceding from which it may be distinguished by its denticulate claws. It may be recognised further by the capitate terminal clasp segment being as long as the basal clasp segment. The pulvilli are as long as the claws.

Genotype.—Epidosis lineatus (Kieff.) (Kieff.).

Dicroneurus indicus Kieff.

1913. *Epidosis indicus*, Kieffer, *Rec. Ind. Mus.*, IX, p. 200.
1913. *Dicroneurus indicus*, Kieffer, *Gen. Ins.*, fas. 152, p. 270.
1920. *Dicroneurus indicus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Dicroneurus indicus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This species was first described under the genus *Epidosis* H. Loew from males taken at Kalighat. It was transferred to *Dicroneurus* in the *Genera Insectorum*. The type is not in the Indian Museum.

Genus Camptomyia Kieff.

1894. *Camptomyia*, Kieffer, *Ann. Soc. Entomol. France*, LXIII, p. 323.
1913. *Camptomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 277.
1915. *Camptomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 180, p. 179.
1925. *Camptomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 142.
1928. *Camptomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This genus comprises about twenty species, mostly from Europe. The midges of this genus breed in decaying vegetable matter. No genotype appears to have been designated.

This genus falls between *Tetradiplosis* Kieff. & Jorg. and *Dirhiza* H. Loew in Felt's key (76) to genera. It is separated from either by its dorsally recurved abdomen. It may be recognised by the following additional characters: Palpi quadriarticulate; antennal segments 16-32; third and fourth segments fused; circumfila in male peculiar, one-looped and sinuous; stems of male antennal segments long but not as long as the segments; stems in female not longer than one half the length of the sub-cylindrical basal enlargement. Wings with three long veins, cross-vein parallel with costa, third vein forming an arch and joining costa at the apex of wing, fifth vein forked. Terminal clasp segment fairly long, sometimes slender or somewhat swollen. Dorsal plate bilobed. Ovipositor basal lamellae biarticulte, terminal lamellae simple.

Key to species.

I. Antennal segments of female 21 . . . . . *C. ricini* Felt.
II. Antennal segments of female 24.
   A. Fifth antennal segment with a length two and half times its diameter, third palpal segment with a length five times its diameter . . *C. morindae* Felt.
   B. Fifth antennal segment with a length one-fourth its diameter, third palpal segment with a length about five times its diameter . . *C. hibisci* Felt.

Camptomyia ricini Felt.

1921. *Camptomyia ricini*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 23.
1928. *Camptomyia ricini*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This species was described from midges bred from dried shoots of *Ricinus communis* Linn. at Coimbatore, South India. According to Felt

this species is typical of the genus. The type is in the New York State Museum.

I refer to this species a number of midges bred from dry, decaying fruit capsules of *Ricinus communis* Linn. at Tanjore, South India. Male 1 mm. long. Antennae one half longer than body and sparsely haired. Mesonotum reddish-brown. Scutellum and post-scutellum pale yellow. Abdomen yellow. Female about 2 mm. long. Antennae sparsely haired. Mesonotum brownish. Scutellum and post-scutellum yellow. Abdomen paler.

Camptomyia morindae Felt.

1926. *Camptomyia morindae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 241.
1928. *Camptomyia morindae*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This species was described from midges bred from larvae found attacking the trunk of *Morinda tinctoria* Roxb. at Coimbatore, South India. The type is in the New York State Museum. This species is represented in Ramachandra Rao collection at Coimbatore.

I refer to this species a series of midges taken on leaves of *Morinda tinctoria* Roxb. at Tanjore. South India. The midges have been observed flying at dusk. Male 1·75 mm. long. Antennae longer than body and thickly haired. Mesonotum dark brown. Scutellum yellow. Abdomen dark yellowish-brown and thickly haired. Female a little shorter than male. Antennae three-fourth the length of body and thickly haired. Mesonotum reddish-brown. Scutellum and post-scutellum dirty yellowish. Abdomen yellowish.

Camptomyia hibisci Felt.

1926. *Camptomyia hibisci*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 241.
1928. *Camptomyia hibisci*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 18.

This species was described from midges bred from rotting stems of *Hibiscus* sp. at Coimbatore, South India. The type is in the New York State Museum. I have not come across this species.

Genus **Lopesiella** Tav.

1908. *Lopesiella*, Tavares, *Broteria*, VII, p. 145.
1913. *Lopesiella*, Kieffer, *Gen. Ins.*, fas. 152, p. 252.
1925. *Lopesiella*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 142.
1928. *Lopesiella*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

This small genus, with only two species, is remarkable for having the antennae resembling those of the genus *Asphondylia* H. Loew, especially in the tortuous circumfili. Kieffer (111) is of the opinion that this genus should be included in the tribe Asphondylariae. Its characters, however, are quite distinctly marked and I am inclined to agree with Felt and retain it in the Porricondylariae.

The species of this genus may be recognised by the following characters: Palpi triarticulate; antennal segments 14, sessile in both sexes, second segment flattend, third segment with a length about four times its diameter and not fused with fourth, terminal segment with a

prolongation, circumfila tortuous as in *Asphondylia* H. Loew; wings with three long veins, fifth vein forked; claws long, not strongly curved, simple; pulvilli rudimentary.

Genotype.—Lopesiella combreti Tav.

Lopesiella polliniae Felt.

1927. *Lopesiella polliniae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, X, pp. 2-3.

1928. *Lopesiella polliniae*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

Midges bred by Ramachandra Rao from galls of *Pollinia argentea* at Thaliparamba, Malabar, South India, were provisionally referred to this genus by Felt. Males of this species have not been noted so far. It is represented in Ramachandra Rao collection at Coimbatore.

Genus **Pruthidiplosis**, nov.

This new genus, named after Dr. Hem Singh Pruthi, is erected for a rather unique midge, which gives rise to corticose galls on flowers of *Mimusops hexandra* Roxb. Its characters are very striking and do not admit of its being referred to any known genus. At first sight this genus may be taken for one of the Itonididinariae but the presence of the distinct cross-vein clearly indicates that it should be referred to this tribe.

It falls between *Allodiplosis* Kieff. and Jorg. and *Holoneurus* Kieff. in Felt's key (76) to genera. It resembles the former in its long-looped circumfila and forked fifth vein, but differs in its biarticulate palpi and simple claws. It resembles *Holoneurus* Kieff. in its obsolete sixth vein but differs in its forked fifth vein and simple claws. From the foregoing genus *Lopesiella* Tav. it may be distinguished by the biarticulate palpi, and long bow-loop circumfila.

The following are its diagnostic characters: Palpi biarticulate; antennal segments 14; flagellate segments of female cylindrical and moderately stemmed; flagellate segments of male binodose and long-stemmed; circumfila of male formed into moderately long, bow-like loops as in the tribe Itonididinariae and in two even whorls as in the genus *Contarinia* Rond. Wings with three long veins; third vein with a distinct cross-vein nearly parallel with costa and apparently a continuation of third vein; fifth vein forked, distally with the branches very faint; sixth vein obsolete. Terminal clasp segment moderately long. Ovipositor short and bilobed.

Genotype.— Pruthidiplosis mimusopsicola, sp. nov.

To indicate the position of *Pruthidiplosis* in the series of genera with the cross-vein parallel or nearly so to the costa I give below a key revised from Felt (76).

I. Wings with three long veins, fifth vein forked, sixth a branch of fifth or wanting.
- A. Circumfila not formed into long loops.
- B. Circumfila formed into long loops.
  - 1. Claws denticulate.
    - *a.* Palpi quadriarticulate . . . *Lopesia* Rubs.
    - *b.* Palpi uniarticulate . . . *Allodiplosis* Kieff. & Jorg.
  - 2. Claws simple.
    - Palpi biarticulate . . . . *Pruthidiplosis*, gen. nov.

II. Wings with three long veins, fifth vein simple, sixth vein obsolete.

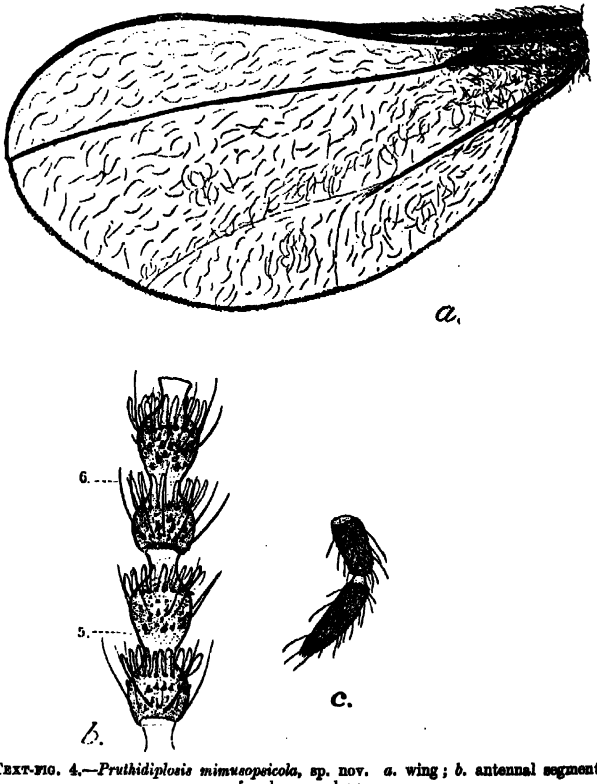
A Claws denticulate.

1. Claws as long or twice as long as pulvilli . *Holoneurus* Kieff.
2. Claws more than twice the length of pulvilli . . . . . . *Coccopsis* Meij.

Pruthidiplosis mimusopsicola, sp. nov.

(Text-figs. 4, 5 & 6.)

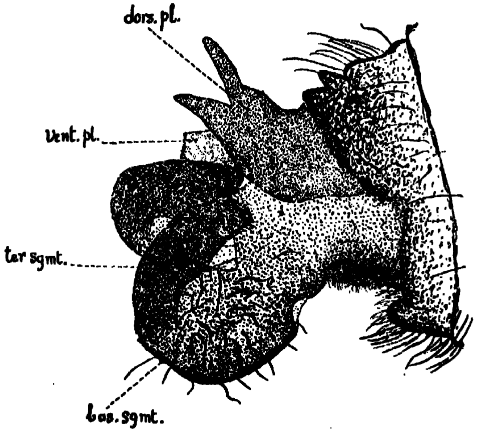
This midge attacks the flower buds of *Mimusops hexandra* Roxb., thus preventing the formation of normal fruits but producing fruit-like corticose galls, *i.e.*, galls with a spongy inner substance and a hard shell-like outer rind.



TEXT-FIG. 4.—*Pruthidiplosis mimusopsicola*, sp. nov. *a.* wing; *b.* antennal segments of male; *c.* palpus.

Male.— 3 mm. long. Body dirty-brown in colour. Antennae two-thirds the length of body; segments 14; third segment with ovoid

enlargements; fifth segment with stems about one-sixth and one-third the diameter of the basal and apical sub-globose enlargements respectively, circumfila loops of this segment as long as the stem on the basal enlargement and half the length of stem on the apical enlargement; sixth segment with stems one-third and one-half the diameters of the basal and apical sub-globose enlargements respectively; terminal segment with a stem one-sixth the length of segment and a little less than half the diameter of the enlargement, the obpyriform apical enlargement with a linear pyriform prolongation nearly equal to the diameter of the enlargement; circumfila on all segments in two even whorls similar to those of the genus *Contarinia* Rond. but with the loops somewhat shorter. Palpi biarticulate; first segment with a length one-fourth greater than its diameter; second segment more slender, about twice the length of first and somewhat reduced towards its apex. Mesonotum brownish-black. Claws simple on all legs. Empodium a little longer than claws. Basal clasp segment of genitalia with numerous dark, stout, strongly chitinised, somewhat curved setae on both inner and outer surfaces. Terminal clasp segment with a length about five times its width, with the tip strongly chitinised and bluntly pointed.



TEXT-FIG. 5.—*Pruthidiplosis mimusopsicola*, sp. nov. Male genitalia; *dors. pl.* dorsal plate; *vent. pl.* ventral plate; *ter. sgmt.* terminal clasp segment; *bas. sgmt.* basal clasp segment.

Female.— 4 mm. long. Body bright reddish in colour. Antennae half the length of body; segments 14, cylindrical; third and fourth segments united, sub-equal, constricted in the middle, with stems roughly one-sixth the length of the enlargements; fifth segment with a stem one-third the length of enlargement which latter has a length a little over twice its diameter; sixth segment with a length one-fourth the length of the enlargement, which latter has a length twice its diameter; twelfth segment with a stem a little less than one-fourth the length of

enlargement, which latter has a length less than twice its diameter; terminal segment one half longer than the one immediately preceding, with a constriction at its apical third; all segments with a thick basal whorl of setae as long as the enlargements and an apical whorl of setae a little shorter than the enlargements. First palpal segment with a length a little over twice its diameter and thickly setose; second segment a little over one half longer than the first, thickly setose and reduced towards the somewhat chitinised tip. Mesonotum dark brown. Scutellum black. Claws simple on all legs and a little longer than empodium. Ovipositor with the terminal lamellae rounded.

Pupae.—4·5 mm. long, stout, cylindrical and dark reddish in colour. Antennal horns (cephalic horns) serrated on the anterior side. The two small thoracic horns pointed backwards. Anal horns closely adpressed. Spiracles of third abdominal segment oval, somewhat larger than those of the others, which are circular. Pupation in galls.

Holo-co-types.—Male, on slide. No. $\frac{980}{H\,6}$ and in spirit No. $\frac{1029}{H\,6}$.

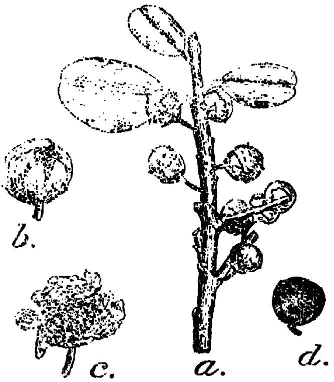
Allotype.—Female, in spirit. No. $\frac{981}{H\,6}$.

Para-co-types.—Two males on slide. No. $\frac{982}{H\,6}$.

Paratypes.—Males and females in spirit. No. $\frac{983}{H\,6}$.

Type-locality.—A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 18.xii.1932.

Galls.—These galls look very much fruits and as such indeed they have found their way to many herbaria. Their true nature cannot be detected except on minute examination.



TEXT-FIG. 6.—*Pruthidiplosis mimusopsicola*, sp. nov. Galls on flowers of *Mimusops hexandra* Roxb. *a.* a twig with galls; *b.* a mature gall about to dehisce, showing cracks in the scleroderm; *c.* old gall showing the exuvia of the midges projecting from the spongy substance; *d.* gall cut into two to show the larval cavities.

10-15 mm. in diameter. Regular, globose, rarely barrel-shaped or obpyriform; dark green and glabrous; dehiscent, acystiferous, with a solid, white, spongy inner substance and a hard outer rind—the scleroderm. They are borne on curved pedicels and are crowded towards the

tip of the stout, cylindrical twigs. Ovoid larval chambers are found in the spongy substance just below the scleroderm.

Really these galls are the flowers, with all the floral envelopes involved. The calyx is often persistent, accrescent and cupiform at the base of the gall; ordinarily the sepals, petals, stamens and style are found as minute, spine-like vestiges on the surface of the galls. When the galls mature, the scleroderm dehisces, exposing the pupae sticking out from the inner substance and thus facilitating easy escape later on of the adult midges.

Tribe Lasiopterariae.

Genus **Lasioptera** Meig.

1818. *Lasioptera*, Meigen, *Syst. Beschr. Europ. Zweifl. Inseckt.*, I, p. 88.
1818. *Diomyza*, Meigen, *Syst. Beschr. Europ. Zweifl. Inseckt.*, I, p. 89.
1853. *Lasioptera*, Winnertz, *Beitr. einer Mon. Gallmuck.*, p. 191.
1862. *Lasioptera*, Osten Sacken, *Mon. N. Amer. Dipt.*, *Cecid.*, p. 175.
1908. *Lasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 124, pp. 323-327.
1913. *Lasioptera*, Kieffer, *Gen. Ins.*, fas. 152, p. 30.
1918. *Lasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 198, p. 107.
1920. *Lasioptera*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 8.
1925. *Lasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 142.
1928. *Lasioptera*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 1.

The genus *Lasioptera* Meig. comprises over one hundred and fifty species distributed all over the whole world. They are gall-making in their habits and attack both herbaceous and woody plants, among which grasses are often prominent. They generally produce galls on shoots, though sometimes galls are also produced on leaves. They have mostly been found in India on members of the natural order Cucurbitaceae. Some species may prove to be of economic importance in India.

The members of this genus are characterised by the presence of thickly scaled and closely approximated costa, sub-costa and third vein. They are characteristically coloured and the dorsum of their abdomen is often conspicuously ornamented by yellowish-white or silvery-white spots or markings. The ovipositor of some species has a number of stout, recurved chitinous hooks. They may be easily recognised by the following additional characters: Palpi quadriarticulate; antennal segments 16-33 in female and 16-22 in male, some species having equal number of segments in both sexes; third and fourth antennal segments fused or nearly so; wings with three long veins, third vein very near costa and uniting therewith at or before the basal half, very rarely beyond the basal third, fifth vein forked at some distance from its base; pulvilli well developed; ventral plate bilobed.

Genotype.--*Lasioptera albipennis* Meig.

Key to species.

I. Abdomen dark brown or black.
  A. Abdominal segments narrowly margined posteriorly with yellowish-white . . . *L. eriochloa* Felt.
  B. Abdomen dorsally with silvery-white sub-median spots.
    1. Antennal segments 18 in female . . *L. fluitans* Felt.
    2. Antennal segments 20 (2+18) . . *L. bryoniae* Schiner.
    3. Antennal segments 24 in female . . *L. falcata* Felt.

II. Abdomen yellowish-brown . . . *L. paniculi* Felt.

Lasioptera eriochloa Felt.

1926. *Lasioptera eriochloa*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 244.
1928. *Lasioptera eriochloa*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 1.

Felt erected this species for midges bred by Ballard from ear-heads of *Eriochloa polystachya* at Coimbatore, South India. The type is in the New York State Museum. This species is represented in Ramachandra Rao collection by one female, 1·2 mm. long. Mesonotum dark reddish-brown, abdomen dark brown, segments narrowly margined posteriorly with yellowish-white.

Lasioptera fluitan Felt.

1917. *Lasioptera fluitans*, Felt, *Entomol. News*, XXVIII, p. 73.
1920. *Lasioptera fluitans*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.
1928. *Lasioptera fluitans*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 2.

This species was described from midges bred by Ramachandra Rao from galls of *Panicum fluitans* at Coimbatore. The type is in the New York State Museum. This species may be recognised by the following characters: Female 1·5 mm. long; antennal segments 18; mesonotum dark brown; scutellum dark reddish-brown; abdomen black, with lunate sub-median, silvery-white spots on segments 1-5.

Lasioptera bryoniae Schiner.

1868. *Lasioptera bryoniae*, Schiner, *Novara Reise Dipt.*, p. 5, pl. i, fig. 2, 3.
1913. *Lasioptera bryoniae*, Kieffer, *Gen. Ins.*, fas. 152, p. 31.
1920. *Lasioptera bryoniae*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.
1928. *Lasioptera bryoniae*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 1.

This species was bred out of shoot galls of *Bryonia* sp. from Vellore in Madras Presidency. The description of the species is unfortunately faulty and I have not seen any specimens.

Lasioptera falcata Felt.

1919. *Lasioptera falcata*, Felt, *Philipp. Journ. Sc.*, XIV, p. 288.
1919. *Lasioptera falcata*, Ramakrishna, *Rep. Proc. Third Entomol. Meet., Pusa*, I, p. 324, pl. xviii, fig. *a* & *b*.

This species was described from a single female bred from stem galls of an unnamed Cucurbit from the Philippines. Midges bred from the well-known vine galls of Bitter gourd, *Momordica charantia* Linn., are also referred by Felt to this species. It is remarkable that this species occurs in such widely separated areas. It is reported to be very common at Coimbatore. The adult midge and its galls are figured by Ramakrishna Ayyar. I have collected it in various localities in South India.

Lasioptera paniculi Felt.

1920. *Lasioptera paniculi*, Felt, *Philipp. Journ. Sc.*, XVII, p. 232.

This species was described from the Philippines from midges bred from panicles of *Panicum carinatum* Presl. It is found in Ramachandra Rao's collection at Coimbatore with the label: Bred from ear-heads of *Panicum prostratum* Lamk., Y. R. Rao, Coimbatore. These midges were

evidently identified by Felt and there seems to be no doubt as to the occurrence of this species in South India. Senior-White does not mention this species in his catalogue.

Lasioptera textor Kieff.

1905. *Lasioptera textor*, Kieffer, *Ann. Soc. Sc. Bruxelles*, XXIX, p. 155.
1920. *Lasioptera textor*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.
1928. *Lasioptera textor*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 2.

Kieffer erected this species for a midge bred from galls of *Polygonum molle.* The sex of the midge described and the type-location are not stated. The fact that the mouth parts are described as prominently prolonged casts doubt on the correctness of Kieffer's identification. It would appear to belong either to the genus *Clinorhyncha* H. Loew or *Ozirhinchus* Rond., but Kieffer's description is not detailed enough for deciding its exact position.

Lasioptera longispatha Kieff.

1908. *Lasioptera longispatha*, Kieffer, *Marcellia*, V, p. 157.
1920. *Lasioptera longispatha*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.

This species was erected by Kieffer from larvae taken from galls of *Camellia drupifera* at Kurseong, Eastern Himalayas. No adult is described. Larval characters, in the absence of a knowledge of their relationship to adult characters, are of doubtful value for taxonomic purposes.

Lasioptera trilobata Kieff.

1908. *Lasioptera trilobata*, Kieffer, *Marcellia*, V, p. 157.

This species was also described by Kieffer from larvae inhabiting the galls of *Schima walchii* at Kurseong. No adults are described.

Genus **Prolasioptera** Kieff.

1913. *Prolasioptera*, Kieffer, *Bull. Soc. Hist. Nat. Metz.*, No. 28, p. 27.
1913. *Prolasioptera*, Kieffer, *Gen. Ins.*, fas. 152, p. 33.
1925. *Prolasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 143.

This genus, not previously recorded from India, was erected by Kieffer for midges closely approaching *Lasioptera* Meig. but departing from it in its triarticulate palpi. It falls between *Lasioptera* Meig. and *Neolasioptera* Felt in Felt's key (76) to genera. It may be distinguished from the latter by its forked fifth vein. Altogether about half a dozen species, mostly from Europe, have been described so far. The midges of this genus pupate in their galls. One new species from the Madras Presidency is described below.

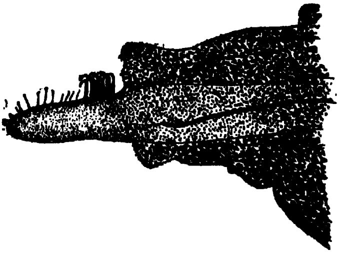
Genotype.—Prolasioptera nivocincta Kieff.

Prolasioptera annandalei, sp. nov.

(Text-fig. 7.)

Female.—1 mm. long. Body yellowish-brown in colour. Antennae nearly half the length of body; segments 18; second segment subglobose; third segment somewhat stouter basally than apically, twice the length of second and more slender; fourth segment a little shorter,

somewhat more slender and more reduced towards the apex than third segment; fifth segment nearly uniform in thickness, sub-equal to fourth and one-fourth greater than its own diameter, very slightly constricted in the middle and with a very short stem; penultimate and terminal segments sub-equal, the former sub-pyriform, the latter pyriform, both with a length a little greater than their diameters. First palpal segment stouter apically than basally, with a length a little greater than its diameter; second segment one-half longer than first, slightly more slender, stout basally and slender apically and sparsely setose; third segment more slender and somewhat more thickly setose than second, twice as long, swollen and club-shaped beyond the basal half. Sub-median lines on the mesonotum scaled. Ovipositor with chitinous hooks from its one-fourth backwards.



TEXT-FIG. 7.—*Prolasioptera annandalei*, sp. nov. Ovipositor showing the dorsal row of chitinous hooks. (Highly magnified).

Holotype.—Female, on the same slide as the holotype of *Thurauia chilkaensis*, sp. nov. No. $\frac{984}{H6}$.

Type-locality.—Barkuda Island, Chilka Lake, Madras Presidency, South India. Coll. N. Annandale.

Genus **Neolasioptera** Felt.

1908. *Neolasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 124, pp. 330-333.
1913. *Neolasioptera*, Kieffer, *Gen. Ins.*, fas. 152, pp. 22-23.
1918. *Neolasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 198, p. 171.
1925. *Neolasioptera*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 143.

This American genus, with about forty species, is recorded here for the first time from India. It is closely related to the two preceding genera, *Lasioptera* Meig. and *Prolasioptera* Kieff., both of which it resembles in general characters and habits. It may be distinguished from them by its simple fifth vein. Antennal segments vary from 17-29 in female and 12-23 in male.

The midges of this genus give rise to shoot galls, chiefly on herbaceous plants and occasionally also on woody plants and grasses. Two new species from South India are described below.

Key to species.

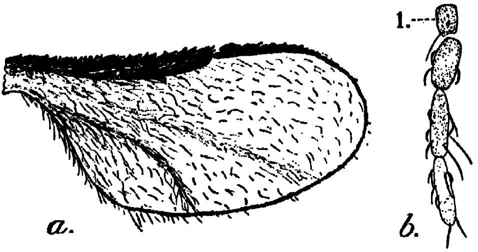
I. Abdomen black, palpi quadriarticulate, empodium as long as claws . . . . *N. cephalandrae*, sp. nov.
II. Abdomen brown, palpi triarticulate, empodium a little longer than claws in hind legs and as long as claws in other legs . . . . *N. crataevae*, sp. nov.

Neolasioptera cephalandrae, sp. nov.

(Text-figs. 8 and 9.)

This new species is described from midges bred from solid stem galls of *Cephalandra indica* Naud., which, though very common in India, does not appear to have been described so far.

Female.— 2 mm. long. Antennae less than one-fourth the length of body, segments 21; first segment obpyriform, with a length nearly equal to its diameter, second irregularly sub-globose, shorter and more slender than first, with a length a little less than its own diameter;



TEXT-FIG. 8.—*Neolasioptera cephalandrae*, sp. nov. *a.* wing; *b.* palpus.

third segment obpyriform, with a length one-fourth shorter than its diameter; fourth segment shortly sub-cylindrical, with a stem one-half the length of the basal enlargement; fifth segment cylindrical, with a length less than half its diameter and with a very short stem; terminal four segments somewhat stout basally; penultimate segment distinctly broadened at base; terminal segment of right antennae short, pyriform and with a length almost equal to its diameter; terminal segment of the left antennae relatively twice longer, coniform and slightly constricted in the middle. Palpi quadriarticulate and sparsely setose; first segment short, cylindrical; second segment short, stout, oblong-ovoid and with a length about twice as long as its diameter; third segment less than half the thickness of second and one-fourth longer; fourth segment a little longer and somewhat more slender than third. Mesonotum brown. Halteres deep flesh-coloured. Tarsi unicolourous. Claws unidentate and as long as empodium. Abdomen covered dorsally with black scales not fully reaching the edges of the side on the posterior margins of segments. Ovipositor one-seventh the length of body, flesh-coloured, terminal portion with a length over twice its diameter, densely covered all round the apex with long stigmatic setae, whose tips are somewhat curved and hook-shaped and with over ten stouter, longer, chitinous hooks basally.

Holotype.—Female, partly dissected in spirit. No. $\frac{985}{H6}$.

Paratypes.—Four females, in spirit. No. $\frac{986}{H6}$.

Type-locality.—A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 15.vii.1933.

Other localities.—Coimbatore, Erode, Vellore, Madras and Calcutta.

TEXT-FIG. 9.—*Neolasioptera cephalandrae*, sp. nov. Shoot galls of *Cephalandra indica* Naud.

Galls.—25-40 mm. long and 15-30 mm. thick. Regular, ovoid, fusiform or moniliform, local or sub-extensive, solid, hard, fleshy, tuberous swellings of the vine. Yellowish-white or pale green, glabrous; cystiferous, indehiscent and with numerous minute circular holes on the surface when old.

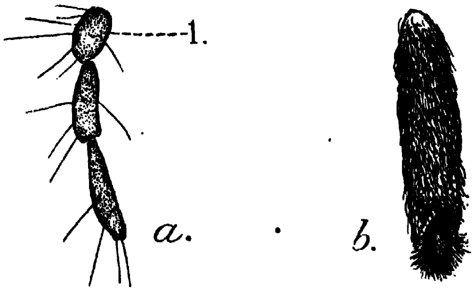
An extensive parenchyma surrounds the large, central, irregularly proliferating zone. Vascular bundles are scattered irregularly both in the parenchyma and the proliferating zone. Cysts are longitudinal and occur in the proliferating zone. The seat of cell proliferation appears to be the medulla of the stem.

Life-history.—Numerous eggs are laid close together on the young vines of *Cephalandra indica* Naud. The eggs hatch out on the fourth day and the maggots penetrate the stem and bore tunnels up and down in the medulla. The larvae continue to develop in the galls and reach maturity in four weeks. They then bore their way to the surface but do not make any hole. They pupate just beneath the epidermis in these cavities; this facilitates the easy escape of the adults, which emerge on the seventh day after the commencement of pupation. Just before the emergence of the adults, the pupae wriggle their way out, piercing the thin epidermis and project from the surface of the gall. The anterior end of the pupal case bursts and the adults escape leaving the exuvium sticking out from the holes. The larvae and pupae of the midges are very heavily parasitised by unknown Chalcid flies. There appear to be at least two generations in one year.

Neolasioptera crataevae, sp. nov.

(Text-figs. 10 and 11.)

This new species is erected for a midge, which attacks the young flower buds of *Crataeva religiosa* Forst. and gives rise to woody galls, not observed by previous workers.



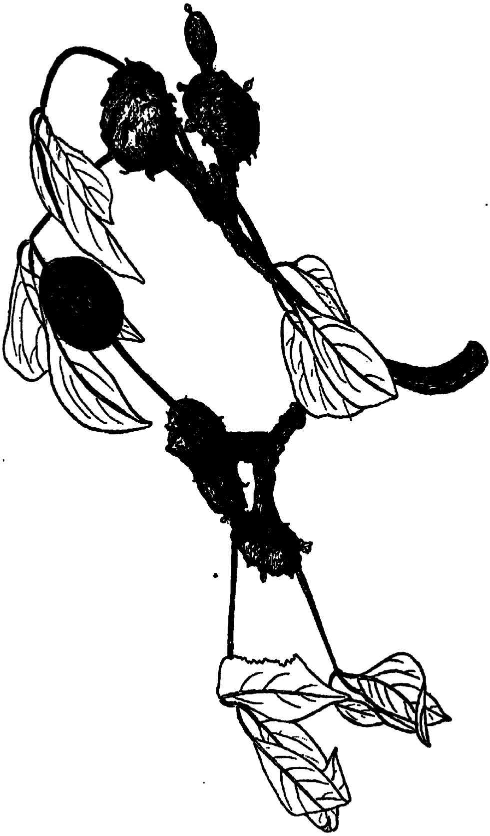
TEXT-FIG. 10.—*Neolasioptera crataevae*, sp. nov. *a.* palpus; *b.* fifth tarsal segment showing unidentate claw and empodium.

Female.—2 mm. long. Antennae one-fourth the length of body, segments 21; first segment broadly obconic, with a length equal to its apical diameter; second segment globose; third segment sub-globose; fifth segment shortly cylindrical, with a length a little greater than its diameter; penultimate segment with a length a little less than twice its diameter; terminal segments in both antennae short, pyriform and with lengths equal to their diameters. Palpi triarticulate and sparsely setose; first segment short, stout and ovoid; second segment with a length thrice its diameter and somewhat stout apically; third segment with a length roughly five times its diameter and a little longer than second, slender basally, rather stout in its apical half and truncate at the very tip. Mesonotum brown. Abdomen pale brown dorsally and yellowish-brown ventrally. Claws unidentate, a little

shorter than empodium and somewhat more sharply bent in hind than in other legs. Ovipositor with setae round apical half short and not stigmatic as in the foregoing species.

Holotype.—Female, in spirit. No. $\frac{987}{H6}$.

Type-locality.—Grand Anicut Canal Bank, Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 19.vii.1933.



TEXT-FIG. 11.—*Neolasioptera crataevae,* sp. nov. Solid flower galls of *Crataeva religiosa* Forst.

Galls.—20-30 mm. in diameter. Regular, globose, generally flattened at the top, funnel-shaped at the base, solitary, clustered or sometimes compound, solid, hard, woody, indehiscent and cystiferous; yellowish-green or brownish-yellow, with reddish-brown spots: horizontal, thick, fleshy, flat out-growths basally, representing the sepals

and petals, and with more numerous short, conical or pyramidal, fleshy, recurved spinous eruptions above, representing the stamens.

Really the galls are the flowers with extensive cell proliferation involving the gynophore, calyx, corolla, stamens and sometimes the pistil also. The main seat of cell proliferation is the part of the flower stalk between the sepals and gynophore. The petals and sometimes the stamens revert to the primitive condition and tend to become small green leaves on the galls. The suppressed ovary and part of the gynophore immediately below it are sometimes found on the gall.

An irregular and broad ring of vascular bundles is embedded in a parenchyma of irregular cells.

Life-history.—The female midge lays eggs on the tender flower buds of *Crataeva religiosa* Forst. and the larvae hatching from them on the second day make their way into the vegetable tissues. As a result the flowers ail to open and in their places large, woody galls are formed. The larval period is presumably long, occupying well over two months. Pupation takes place in the galls and the pupal period is fifteen days. There appears to be only one generation in a year.

Genus **Stefaniola** Kieff.

1904. *Stefaniella (partim)*. Tavares, *Broteria*, III, p. 293.
1913. *Stefaniola*, Kieffer, *Bull. Soc. Hist. Nat. Metz.*, XXVIII, p. 45.
1913. *Stefaniola*, Kieffer, *Gen. Ins.*, fas. 152, p. 27.
1925. *Stefaniola*. Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 143.

This genus has not been previously recorded from India. It closely approaches *Stefaniella* Kieff. but is readily distinguished from it by its uniarticulate palpi and 11 antennal segments. According to Kieffer the first two flagellate antennal segments are fused together. Felt, however, places this genus in the series in which these segments are not fused. It falls between *Dibaldratia* Kieff. and *Salsolomyia* Tav. in Felt's key (76) to genera. As at present recognised, this genus is characterised by its obliquely truncate ovipositor dorsally having a row of hooks and by its small head well covered over by the mesonotum.

Genotype.—*Stefaniola salsolae* (Tav.).

Stefaniola bengalensis, sp. nov.

This new species is erected for a single female (?) in the collection of the Zoological Survey of India, Indian Museum. Except the antennae, part of wings and legs, the other parts are very badly damaged. The well-developed pulvilli and the 20 antennal segments are not strictly typical of the genus as defined by Kieffer. The uniarticulate palpi and the small head well under the mesonotum are strongly in favour of its being included in the genus as characterised by Felt. As it does not approach any other known genus so closely, I refer the midge, in spite of these variations, to this genus.

Antennal segments 20, moderately setose, third segment with a length a little greater than its diameter, fourth and fifth segments with lengths roughly equal to their diameters, terminal segment pyriform, with a length one-third greater than the basal diameter. Palpi uniarticulate, thickly scaled and with a length two and half times its

diameter. Claws simple, strongly curved. Empodium well developed and longer than claws.

Holotype.—Partly dissected on slide. No. $\frac{988}{\text{ii } 6}$.

Type-locality.—Port Canning, Bengal. Museum Coll. 6.xii.1907.

Tribe DASYNEURARIAE.

Genus **Hallomyia** Kieff.

1912. *Hallomyia*, Kieffer, *Spol. Zeyl.*, VIII, p. 25.
1913. *Hallomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 106.
1920. *Hallomyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 11.
1925. *Hallomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 144.
1928. *Hallomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 6.

This genus, with only one species, appears to be closely related to *Stomatosema* Kieff. from which it is distinguished by its 13 antennal segments and spotted wings. Palpi are quadriarticulate. Empodium half the length of claws. Third vein is united with costa beyond the apex of wing.

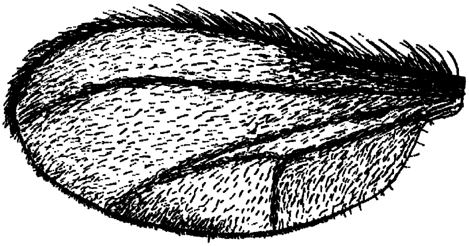
Genotype.—*Hallomyia iris* Kieff. (By original designation.)

Hallomyia iris Kieff.

(Text-fig. 12.)

1912. *Hallomyia iris*, Kieffer, *Spol. Zeyl.*, VIII, p. 25.

This species was described from Ceylon. The type-location is not stated. Brunetti records that three paratypes are in the Indian Museum. Except for one very badly damaged specimen, the other two have completely disappeared due to bad preservation. I have mounted (Slide No. $\frac{989}{\text{ii } 6}$) this midge to prevent its further deterioration and figure its wing to show the third vein making an arch and uniting with costa



TEXT-FIG. 12.—*Hallomyia iris* Kieff. Wing.

beyond the apex of wing. The round spots on the wings described by Kieffer are not visible in the specimen. The head, showing the somewhat prolonged mouth parts and the terminal part of antennae, have been figured by Kieffer.

Genus **Trichoperrisia** Kieff.

1913. *Trichoperrisia*, Kieffer, *Rec. Ind. Mus.*, IX, p. 199.
1913. *Trichoperrisia*, Kieffer, *Gen. Ins.*, fas. 152, p. 65.
1920. *Trichoperrisia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 10.
1925. *Trichoperrisia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 145.
1928. *Trichoperrisia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 3.

This genus is distinguished from the foregoing by its third vein uniting with costa at or near the apex of wing, by its 18 antennal segments and by its claws being longer than pulvilli. A single species, *pipericola* Kieff., was described by Kieffer from midges bred from leaf galls of *Piper nigrum* at Peradeniya, Ceylon.

Genotype.—Trichoperrisia pipericola Kieff.

Genus **Dasyneura** Rond.

1840. *Dasyneura*, Rondani, *Sopra alcuni nuovi generi d'Insetti Ditteri*, p. 17.
1840. *Dasyneura*, Rondani, *Nuov. Ann. Soc. Bologna*, (2) VI, p. 12.
1908. *Dasyneura*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 340.
1913. *Dasyneura*, Kieffer, *Gen. Ins.*, fas. 152, p. 86.
1920. *Dasyneura*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 10.
1925. *Dasyneura*, Felt, *Bull. N. Y. St. Mus.*, No. 145.
1928. *Dasyneura*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 3.

This is the most typical genus of the tribe and includes about one hundred species, distributed all over the principal continental areas. The midges of this genus give rise to galls on fruits, buds and leaves. Many species are of considerable economic importance, due either to the injury they cause to cultivated plants or to checking the spread of weed pests. Only two species have so far been described from India.

The genus may be recognised by the following characters: Palpi quadriarticulate; antennal segments generally 14, circumfila not greatly produced; wings with three long veins not distinctly scaled, third vein uniting with costa well beyond the apex of wing and fifth vein forked; claws toothed on all legs; ovipositor long, sometimes longer than the body.

Genotype.—Dasyneura obscura Rond.

Key to species.

I. Antennal segments 12, fifth segment with a length about two and a half times its diameter, third palpal segment with a length three times the second, mesonotum yellowish-brown . . . . . . *D. gossypii* Felt.

II. Antennal segments 14, fifth segment with a length about three-fourths greater than its diameter, third palpal segment one-half longer than second, mesonotum reddish-brown . . . . . *D. mangiferae* Felt.

Dasyneura gossypii Felt.

1916. *Dasyneura gossypii*, Felt, *Can. Entomol.*, XLVIII, p. 29.

This species is sometimes a minor pest of cotton. It infests the buds, causing them to wither and drop. It pupates in the withering buds.

Dasyneura mangiferae Felt.

1927. *Dasyneura mangiferae*, Felt, *Mem. Dept. Agric. Ind.*, *Entomol. Ser.* X, p. 1.

This species is recorded to have been bred from galls on flowers of *Mangifera indica* Linn. No description of the gall is given. I have not come accross this midge.

Genus **Harpomyia** Felt.

1916. *Harpomyia*, Felt, *Can. Entomol.*, XLVIII, p. 40.
1920. *Harpomyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 10.
1925. *Harpomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 146.
1928. *Harpomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 3.

This small genus, with only one species, falls between *Arnoldia* Kieff. and *Neuromyia* Felt in the group of genera with quadriarticulate palpi in Felt's key (76). It is easily recognised by its greatly produced, sickle-shaped harpes. The following are additional characters: Antennal segments 12, flagellate segments sessile in both sexes; thorax and abdomen not plainly covered with scales; third vein united with costa near the apex of wing; terminal clasp segment swollen.

Genotype.—Harpomyia indica Felt.

Harpomyia indica Felt.

1916. *Harpomyia indica*, Felt, *Can. Entomol.*, XLVIII, p. 401.

The special interest of this species is its peculiar food habit. It is recorded to have been bred from larvae found in the lining of an old felt cap. Whether the larvae actually fed on the substance of the felt cap or on some form of fungus growth on it is not definitely stated. If it is hereafter proved that the maggots had actually been feeding on the felt cap, the species would have to be classed as a potential household pest.

Tribe Oligotrophiariae.

Genus **Oligotrophus** Latr.

1758. *Tipula (partim)*, Linne, *Syst. Nat.*, ed. 10, p. 588.
1805. *Oligotrophus*, Latreille, *Hist. Crust. Ins.*, XIV, p. 288.
1854. *Hormomyia (partim)*, Winnertz, *Stett. Entomol. Zeit.*, XV, p. 322.
1892. *Oligotrophus*, Rubsaamen, *Berl. Entomol. Zeit.*, XXXVIII, p. 376.
1908. *Oligotrophus*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 368.
1913. *Oligotrophus*, Kieffer, *Gen. Ins.*, fas. 152, p. 49.
1920. *Oligotrophus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.
1925. *Oligotrophus*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 149.
1928. *Oligotrophus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 2.

This genus comprises a number of midges closely approaching *Dasyneura* Rond. and *Rhabdophaga* West. but differing in their simple claws on all legs. They may be recognised by the following characters: Palpi triarticulate; third and fourth antennal segments not fused; empodium twice as long as claws; ovipositor not chitinised, truncate and apically without any distinct pocket; terminal clasp segment apical and small.

Genotype.—Olygotrophus juniperinus (Linn.).

Only one species, *saligneus*, is known in the adult stage from India. The authorship of this species is not definitely known but is generally ascribed to de Niceville, but no description of this species has ever been published. Kieffer has erected a number of species on larval and pupal characters, but described no adults. The genus as a whole requires revision.

List of species.

O. saligneus de Niceville (?) (1903) *Ind. Mus. Notes*, V, p. 151; Lefroy, (1909) *Ind. Ins. Life*, p. 582, fig. 377.
O. indicus Kieff. (1908) *Marcellia*, VII, p. 152.
O. mangiferae Kieff. (1908) *Marcellia*, VII, p. 15.
O. quadrilobatus Kieff. (1908) *Marcellia*, VII, p. 151.
O. tenuispatha Kieff. (1908) *Marcellia*, VII, p. 150.

Genus **Panteliola** Kieff.

1860. *Cecidomyia* (*partim*), Osten Sacken, *Trans. American Entomol. Soc.*, II, p. 302.
1893. *Rhopalomyia* (*partim*), Rubsaamen, *Berlin Entomol. Zeit.*, XXXVIII, p. 162.
1905. *Rhopalomyia* (*partim*), Kieffer, *Ann. Soc. Sc. Bruxelles*, XXIX, p. 151.
1913. *Panteliola*, Kieffer, *Bull. Soc. Nat. Hist. Metz.*, XXVIII, p. 49.
1913. *Panteliola*, Kieffer, *Gen. Ins.*, fas. 152, p. 46.
1920. *Panteliola*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 9.
1928. *Panteliola*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 2.

This genus comprises about five species, most of which were originally referred to the genus *Rhopalomyia* Rubs. It is closely related to *Misospatha* Kieff., which it resembles in all characters, except in its biarticulate palpi.

Genotype.—Panteliola hassi (Kieff.).

Panteliola hassi (Kieff.).

1905. *Rhopalomyia hassi*, Kieffer, *Ann. Soc. Sc. Bruxelles*, XXIX, p. 151.
1913. *Panteliola hassi*, Kieffer, *Bull. Nat. Hist. Soc. Metz.*, XXVIII, p. 49.

This species is recorded as having been bred from galls on the shoot of *Artemisia herba-alba*. It is erroneously described as a Bengal species, for it was collected at Tuticorin, South India.

Tribe ASPHONDYLARIAE.

Genus **Schizomyia** Kieff.

1889. *Schizomyia*, Kieffer, *Entomol. Nachr.*, XIV, p. 183.
1908. *Schizomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 378.
1913. *Schizomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 88.
1916. *Schizomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 186, p. 102.
1920. *Schizomyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 10.
1925. *Schizomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 151.
1928. *Schizomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 4.

The midges of this genus breed in leaf, flower or fruit galls. Four species have so far been described from India. One new species is described below.

The genus is recognised by the following characters: Palpi quadriarticulate. Antennal segments 14, cylindrical, sessile or sub-sessile. Flagellate segments of male with whorls of long hairs and stout, raised

and highly convolute circumfili. Terminal antennal segments of female reduced and shortened. Terminal clasp segment of male genitalia unidentate. Basal clasp segment projects beyond the insertion of terminal clasp segment. Ovipositor aciculate, with a basal fleshy part but without dorsal pouch and lamellae. Ventral sclerite of seventh abdominal segment somewhat strongly chitinised. Larval breast-bone bidentate.

Genotype.—*Schizomyia galli* Kieff. (By original designation.)

Key to species.

Felt (29) has separated the species of this genus by the colour of their abdomen. As it is difficult to determine the colour of spirit specimens, I have used the more satisfactory character of the pulvilli in the following key. The two species, *incerta* and *indica* of Kieffer (105), described from larvae only, are not included in this key.

I. Pulvilli rudimentary.
  A. Antennae three-fourths the length of body, fifth antennal segment with a length two and half times its diameter . . . . . *S. maeruae* Felt.
  B. Antennae as long as body, fifth antennal segment with a length four times its diameter . *S. assamensis* Felt.
II. Pulvilli well developed, shorter than claws . . *S. acaciae*, sp. nov.

Schizomyia maeruae Felt.

1926. *Schizomyia maeruae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 243.

This species was bred by Ballard from galls on *Maerua arenaria* H. F. & T. at Coimbatore, South India. This species appears to be somewhat peculiar on account of the absence of chitinisation of the ventral sclerite of the seventh abdominal segment. It is probably associated with a cluster gall on the flowers of *Maerua arenaria* H. F. & T., which I collected at Tanjore, South India, but unfortunately no midges could be reared out of it.

Schizomyia assamensis Felt.

1920. *Schizomyia assamensis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 3.

This species was bred by Fletcher from galls on leaves of *Rubus assamensis* at Shillong, Assam, East India. It is remarkable on account of its thicklyhaired sub-median lines.

Schizomyia acaciae, sp. nov.

(Plate VII, fig. 1.)

This new species is described from a single female bred from tomentose gall on leaves of *Acacia leucophloea* Willd. It is remarkable on

account of its heavily chitinised ventral sclerite of the seventh abdominal segment.

Female.— 1 mm. long. Body dark brown and densely hairy. Antennae one-fourth the length of body, segments 14, fourth, fifth and sixth segments sub-equal, seventh a little shorter than sixth, terminal segment globose. First palpal segment broadly ovoid, stout and with a length about twice its diameter; second segment longer and more slender; third and fourth segments sub-equal and a little longer than second. Mesonotum black. Claws simple and slender. Pulvilli about half the length of claws. Ovipositor one-fifth the length of body. Ventral sclerite of seventh abdominal segment heavily chitinised.

Holotype.—Female, partly dissected on slide. No. $\frac{990}{H\ 6}$.

Type-locality.—A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 15. vii. 1932.

Galls.—This new gall, for which the name tomentose gall has been proposed, is rather remarkable on account of its being formed by the cell proliferation and fusion of two adjacent leaflets on the same side of the pinna. It is thickly clothed with a brown tomentum.

8 mm. long and 5-6 mm. thick. Regular, simple, collective or compound; pyriform, shortly sub-cylindrical or hour-glass shaped, ventricose, externally bilobed; sessile or with two short petioles; solid, indehiscent uni- or bilocular and acystiferous. Alternate, opposite, scattered or crowded on the secondary rachis to the extent of about 30 galls per leaf. Covered with a dark yellowish-brown or reddish-brown tomentum on the surface and apically with a pair of short, narrow and oblong or broad, long and sagitate, dark green, foliaceous wings, which represent the normal apical portions of the leaflets.

There is a thick cortex of several layers of large, round or hexagonal simple parenchymatous cells, with chloropyll. The cells of the outermost layer of this cortex grow into the tomentose hairs. Palisade and spongy parenchymae of the normal leaflets are completely degenerated. Numerous groups of vascular bundles, resulting from the degeneration of veins, are arranged in the form of a broken ring, as in stems. This ring separates the cortex from the inner, white, annular, medulla of small proliferating cells. The central part is hollow and forms the cavity of the gall. Sometimes there are two such spaces in the medulla, representing the two cells of the gall.

Life-history.— Eggs are laid on the tender buds. Larvae hatch out from them on the third day. They lie in between two minute, closely applied leaflets and absorb nourishment from both of them. This occasions cell proliferation in the two leaflets, which soon swell out near the base and fuse together. The tomentum on the surface of the gall appears in about a week. The larval period is a long one and extends over two months. The pupation is in the galls and takes about five days. Before pupating, the larvae bore a hole to the outside, so as to facilitate the easy escape of the adult. There appear to be two generations, one in summer and another in rainy season. Pupae are parasitised by Hymenoptera through the holes made by the larvae for the escape of the adult midge.

Genus **Asphondylia** H. Loew.

1818. *Cecidomyia* (*partim*), Meigen, *Syst. Beschr.*, I, p. 98.
1850. *Asphondylia*, Herman Loew, *Diptera Beiträge*, IV, p. 21.
1853. *Asphondylia*, Winnertz, *Linn. Ent.*, VIII, p. 187.
1856. *Phyllophaga*, Rondani, *Dipt. Ital. Prodr.*, I, p. 199.
1862. *Asphondylia*, Osten Sacken, *Mon. N. Amer. Dipt.*, I, p. 176.
1863. *Cylindracera*, Lioy, *Atti. Inst. Veneto*, (3) IX, p. 503.
1864. *Asphondylia*, Schiner, *Fauna Austriaca*, II, p. 395.
1869. *Asphondylia*, Osten Sacken, *Trans. American Entomol. Soc.*, p. 209.
1908. *Asphondylia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 375.
1913. *Asphondylia*, Kieffer, *Gen. Ins.*, fas. 152, p. 91.
1913. *Monasphondylia*, Kieffer, *Gen. Ins.*, fas. 152, p. 95.
1916. *Asphondylia*, Felt, *Bull. N. Y. St. Mus.*, No. 186, p. 144.
1920. *Asphondylia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 10.
1925. *Asphondylia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 151.
1928. *Asphondylia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 4.

This is a large genus, with a world-wide distribution. It comprises medium- or large-sized, brown, red or black coloured midges, which breed by preference in leaf and flower galls. Seven Indian species of this genus have been described so far. Some of these species are likely to be of economic importance, such as the sesamum gall fly, *Asphondylia sesami* Felt, which often becomes a pest. Three new species are described below.

The genus is closely related to *Schizomyia* Kieff.; which it resembles in its protractile, aciculate ovipositor and in the general structure of the antennae but differs in the lobed, dorsal pouch at the base of its ovipositor and in its palpi not being quadriarticulate. The midges of this genus may be recognised by the following characters: Palpi tri- bi- or rarely uniarticulate. Antennal segments 14, elongate, cylindrical and sessile; terminal segments of male slightly reduced; terminal segments of female greatly reduced, the last segment subglobose or sometimes even disc-shaped. Circumfila of female consist of two simple bands, one low basal band connected by a branch produced on one side of the segment with a low apical band. Circumfila of male very highly tortuous. Third vein united with costa near the apex of wing. Claws simple. Terminal clasp segment of male genitalia short, stout, swollen near the middle, uni- or bidentate and strongly chitinised apically. Ovipositor aciculate, protractile and with a lobed, dorsal pouch, not vesiculate basally, situated at the proximal end.

Genotype.—*Asphondylia sarothamni* (H. Loew).

Key to species.

I. Palpi biarticulate.
 A. Pulvilli shorter than claws . . . . . *A. morindae* Mani.
 B. Pulvilli as long as claws.
  1. Fifth antennal segment with a length about seven times its diameter in male and five times in female . . *A. sesami* Felt.
  2. Fifth antennal segment with a length about five times its diameter in female . . . . *A. utriculae*, sp. nov.
 C. Pulvilli as long as claws in fore and longer than claws in hind legs . . . . . . *A. riveae*, sp. nov.

II. Palpi triarticulate.

A. Pulvilli shorter than claws . . . . . *A. lantanae* Felt.

B. Pulvilli as long as claws.

1. Second and third palpal segments equal.

a. Mesonotum shiny black, sub-median lines thickly haired in female . *A. osbeckiae* Senior-White.

b. Mesonotum dark brown, sub-median lines sparsely haired in male . *A. trichocecidarum*, sp. nov.

2. Second and third palpal segments unequal.

a. Terminal clasp segment unidentate *A. ipomoeae* Felt.

b. Terminal clasp segment bidentate . *A. pongamiae* Felt.

C. Pulvilli longer than claws . . . . . *A. phyllanthi* Felt.

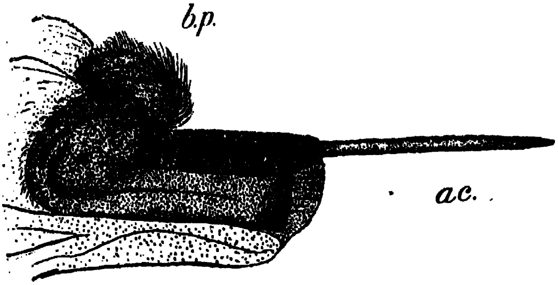
Asphondylia morindae Mani.

(Plate VII, fig. 2 and Text figs. 13 and 14).

1934. *Asphondylia morindae*, Mani, *Ann. Mag. Nat. Hist. London*, (10) XIII, pp. 134-137, figs. A and B.

This species attacks the inflorescence of *Morinda tinctoria* Roxb. and produces large, globose, fleshy galls, very closely resembling the normal fruits. Its galls may be distinguished from the true fruits of

TEXT-FIG. 13.—*Asphondylia morindae* Mani. Claws and related structures. (Highly magnified.)



TEXT-FIG. 14.—*Asphondylia morindae* Mani. Ovipositor; *ac.* acicula; *b.p.* basal pouch

Morinda by the absence of seeds and by the presence of maggots inside them. Though I have already given figures of the gall, I have not described it so far.

Galls.—There are three distinct varieties of this gall: solitary, compound and in clusters.

Solitary variety :—This type of gall is formed when one or two flowers in the inflorescence are attacked. The thalamus swells into globose, pyriform, fleshy galls about 20-30 mm. in diameter.

Clustered variety :—This type of gall is due to several flowers of the same inflorescence being attacked. Several globose, fleshy galls form and are found clustered on the top of the peduncle. Each gall is separate from the other and there is no fusion of the product of different flowers.

Compound variety :—In this type of gall almost all the flowers of the inflorescence grow very close together into galls, which fuse into one single, large, irregular mass. The galls of the individual flowers are not distinguishable, but their extent is marked out on the surface by green lines enclosing irregular areas, as in the case of the true fruits. This variety is very much larger than the other two and sometimes reaches 50 mm. in diameter.

All the varieties are solid, fleshy, acystiferous and indehiscent. Centres of cell proliferation are thalamus, base of corolla and calyx. Ovary and stamens are completely degenerated. Vascular bundles are scattered irregularly in a parenchyma of several layers of large, hexagonal cells.

Life-history.—Eggs are laid on the tender inflorescence. Maggots hatch from them on the second or the third day. They penetrate the young flower buds and bore their way down to the thalamus through the corolla. This occasions the formation of galls. The larval period is a long one and occupies about two and half months. Pupation takes place below the epidermis of the gall. Pupal period is nine days. Pupae are heavily parasitised by Chalcids.

Asphondylia sesami Felt.

1916. *Asphondylia sesami*, Felt, *Can. Entomol.*, XLVIII, p. 31.

This midge infests the flowers, buds and fruits of *Sesamum indicum* Linn. and gives rise to wrinkled and twisted galls. Corolla and stamens degenerate and seeds fail to form. Fletcher (79) regards this species as a minor pest.

Asphondylia utriculae, sp. nov.

(Plate VII, fig. 3.)

This new species gives rise to utricle or bladder-like galls on the ovary of *Dichrostachys cineria* W. & A. It is described from a single female bred from these galls.

Female.— 2·5 mm. long. Antennae about three-fourths the length of body, segments 14; fifth segment with a length five times its diameter and somewhat thicker apically than basally; sixth segment with a length a little over three times its diameter and with a very short stem; seventh segment nearly equal to the sixth and with a stem a

little longer than that of the sixth; twelfth segment with a length one-quarter greater than its diameter and a little less than three-fourths the length of eleventh; thirteenth segment short, stout and with a length almost equal to its diameter; terminal segment oblate, with a length one-fourth less than its diameter. Palpi biarticulate; first segment short, stout, with a length two-fifths greater than its diameter and with a basal whorl of long slender setae and an apical whorl of shorter setae; second segment over twice as long as the first and six times its own diameter, slender and setose beyond its basal fourth. Mesonotum dark brown. Scutellum setose. Abdomen sparsely setose. Claws sharply bent and as long as pulvilli.

Holotype.—Female, in spirit. No. $\frac{901}{H6}$.

Type-locality.—A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 14. i. 1931.

Galls.—These galls, not recorded previously, are homologically the monocarpellary ovaries of the flowers in the spicate inflorescence. 10 mm. long and 5 mm. thick. Regular, globose or pyriform, sessile or sub-sessile, utricular, unilocular, indehiscent, free structures, crowded in large numbers towards the apical portion of the peduncle. Green, pubescent, sometimes villous; basally cupiferous, apically caudate; bladder tough, coriaceous and moderately thick. Large holes, with the exuvium projecting through them are found on old galls. Mechanical tissues are not developed in the bladder. Parenchymatous cells are increased. A single larva of the midge was found in the cavity of the gall.

The basal cup represents the atrophied calyx. Dried-up stamens are found as numerous brown hairs surrounding the galls. The apical tail is the style of the flower.

Life-history.—Not known in detail. Larval period appears to be short, and is presumably about fifteen to twenty days. Pupation takes place within the galls and takes five to six days. Hymenopterous parasites, chiefly Braconidae, were reared from the galls.

Asphondylia riveae, sp. nov.

This new species gives rise to large spongy galls on the leaves of *Rivea hypocrateriformis* Choisy. The description is based on a somewhat mutilated male bred from the galls.

Male.— 2 mm. long. Body dark brown. Antennae distal part broken; third segment with a length five times its diameter; fourth segment somewhat stouter and one-fourth shorter than third; fifth segment with a length three times its diameter. Palpi biarticulate; first segment short, stout, cylindrical and thickly setose; second segment sub-fusiform, twice as long as first and thickly setose. Mesonotum black, sub-median lines thickly haired. Scutellum and post-scutellum black. Claws slightly bent in fore- and mid-legs and sharply bent in hind legs. Pulvilli as long as claws in fore legs and longer than claws in hind legs. Abdomen dark brown and moderately hairy. Genitalia black; basal clasp segment sub-trapezoid, one and half times as long as broad and rather thickly setose; terminal clasp segment sub-globose, unidentate and rather heavily chitinised.

Holotype.—Male, on slide. No. $\frac{992}{H6}$.

Paratypes.—Two males, in spirit. No. $\frac{993}{H6}$.

Type-locality.—A scrub-jungle, near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 30. xii. 1928.

Galls.— 75 mm. long and 20 mm. thick. Regular, globose, ovoid, ellipsoid or rarely irregular; pale or yellowish-green and sometimes mottled with brownish-red or violet, marked with a net-work of dark green; glabrous, very rarely verrucose, with circular holes on old ones; solid, white, spongy, acystiferous and indehiscent; dorsally ribbed, ventrally sulcate and narrowly alate, apically also alate.

Occasionally the galls are long, sub-cylindrical and bright yellow. These galls are really the leaves and are formed by cell proliferation and fusion of the folded halves on either side of the midrib. The surface of the gall is the underside of leaves. The dorsal ridge represents the midrib, while the wings represent normal portions of the leaves.

The epidermis encloses a well developed palisade parenchyma of moderately long cells. This palisade is really formed out of the spongy parenchyma of the normal leaf. By gall formation the leaf is folded along the midrib on the upper side, thus enclosing the normal palisade. The normal spongy tissue appears on the outside of the gall and being exposed to rays of the sun, the cells lengthen out and take the shape and function of palisade cells. The normal palisade cells degenerate and become lost in the thick parenchyma in the interior of the gall. They lose their chlorophyll and cease functioning. The whole mass of the gall is made of large, irregular parenchymatous cells, with large air spaces between them. The veins of the leaf are not degenerated and may be found scattered irregularly in the parenchyma of the gall. Numerous larvae of the midge are found in the deep interior of the gall.

Life-history.—Numerous eggs are laid between the folds of the unopened leaves in the buds. Larvae hatch out on the fourth or fifth day. They attack the palisade surface of the leaf on either side of them. This occasions cell proliferation in the latter and the two portions are bound together. The larvae continue to develop in the galls thus formed for over three months and then pupate at various depths in the gall. Pupal period occupies about ten days. Before the adults emerge, the pupae wriggle their way through the spongy cells to the surface of the gall and with the help of the antennal horns pierce the epidermis, thus facilitating the escape of the adult midges. The larvae and pupae and presumably also the adults are very heavily parasitised by Chalcids. When larvae are parasitised, the gall remains very small and contorted. There is only one generation in the year. The midges appear to hibernate during the hot summer months and part of the rainy season. Galls appear from September to March.

Asphondylia lantanae Felt.

1920. *Asphondylia lantanae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 2.

This species breeds in the flowers of *Lantana indica* and *Lantana camara* in very large numbers. Ramachandra Rao (141) considers

this species as of very little value in the control of *Lantana*. This is partly due to the fact that the midges are very heavily parasitised by Chalcids, so that the midges do not appreciably reduce the seed production of *Lantana*. Recently, however, I (127) have observed that in the absence of the parasites, this species is able to control *Lantana* to an appreciable extent.

Asphondylia osbeckiae Senior-White.

1920. *Asphondylia osbeckiae*, Senior-White, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, pp. 83, 107, pl. XV, fig. 1.

This species was described from a single female taken on the flower of *Osbeckia*, at Shillong, Assam. Senior-White describes the ovipositor as peculiar and his figure shows the terminal aciculate portion bent sharply at right angles to the basal part. This character and the structure of the circumfila described by Senior-White are not strictly typical of this genus, and presumably this midge may have to be referred to a new genus.

Senior-White describes the palpi as biarticulate disregarding the basal segment, which he is inclined to take as palpiger. The general view, however, is to describe the basal joint as the first segment. The palpi are thus in reality triarticulate, under which category I have placed this species in the key.

Asphondylia trichocecidarum, sp. nov.

(Text-fig. 15.)

This new species gives rise to trichocecidia or hairy galls on the leaves of *Acacia leucophloea* Willd.

Male.—1 mm. long, dark yellowish-brown and moderately setose. Antennae as long as body; segments 14; fifth segment with a stem one-seventh the length of the enlargement, which latter has a length twice its diameter; sixth segment a little shorter than fifth; seventh segment as long as sixth; eleventh segment with a length twice its diameter and with a stem one-sixth the length of enlargement; twelfth segment as long as eleventh, a little more slender and with a longer stem; terminal segment with a length twice its diameter and evenly rounded at the tip. Palpi triarticulate; first segment stout, with a length a little over twice its diameter; second segment more slender, reduced towards apex, with a length four times its diameter; third segment stouter than the second and nearly as long. Mesonotum dark brown. Scutellum brown. Halteres fuscous yellow. Femur yellow. Tibia and tarsus darker. Claws simple as long as pulvilli. Genitalia fuscous-yellow basally and darker apically; terminal clasp segment spatulate, unidentate and shortly setose.

Holotype.—Male, partly dissected on slide. No. $\frac{994}{H6}$.

Type-locality.—A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 31. viii. 1931.

Galls.—The galls of this species are formed by cell proliferation and the fusion of two adjacent, closely applied leaflets of the same side of

the secondary rachis on the pinna. They are small hairy balls greatly resembling the flower heads of the plant.

3 mm. in diameter. Regular, globose or pyriform; sessile, light brown, densely hairy; hard, solid, acystiferous, indehiscent, uni- or bilocular, apically bialate; free and solitary, paired or crowded on the pinna.

TEXT-FIG. 15.—*Asphondylia trichoeccidarum*, sp. nov. Trichococcidia on leaves of *Acacia leucophloea* Willd.

The palisade and spongy parenchymae of the leaflets completely degenerated. Epidermal cells, derived from the spongy side of one leaflet and palisade side of another leaflet, converted into the hairy out-growths. Hairs brownish, villous, slightly tapering towards their tips and multicellular. Basal cells of the hairs colourless and full of protoplasm, terminal cells dead and brown. Below the epidermal layer a moderately broad parenchyma of hexagonal cells surrounds an inner circular zone of smaller, proliferating cells. The cells of the parenchyma contain chlorophyll and some of the outermost layers are modified into a somewhat short palisade tissue, though they are in reality derived from the spongy cells of the normal leaflets. Veins are scattered in the form of a ring in the parenchyma, as in the ordinary dicotyledonous stem.

Asphondylia ipomoeae Felt.

1926. *Asphondylia ipomoeae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 243.

This species was bred from galls on *Ipomea staphylina* R. & S. I refer to this species two midges bred by me from galls on buds and leaves of *Ipomea staphylina* R. & S. taken at Erode and Tanjore, South India. The galls have not been described so far. They are globose or pyriform, coriaceous, unilocular, greenish structures on the upper surfaces of leaves, always connecting together the two halves

of the leaves on either side of the midrib by a very slender pedicel. They are about 5-7 mm. in diameter.

Asphondylia pongamiae Felt.

1921. *Asphondylia pongamiae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 24.

This species was bred by Ramakrishna Ayyar from flower galls of *Pongamia glabra* Vent. The galls are described as globose, 1-2 mm. in diameter and with a thin shell. I have not come across this species.

Asphondylia phyllanthi Felt.

1920. *Asphondylia phyllanthi*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 2.

This species is recorded to have been bred by Ramachandra Rao from shiny, globose galls on leaves and shoot of *Phyllanthus emblica* Linn. in Burma. It does not appear to occur in other parts of India.

Genus **Daphnephila** Kieff.

1905. *Daphnephila*, Kieffer, *Ann. Soc. Sc. Bruxelles*, XXIX, p. 144.
1913. *Daphnephila*, Kieffer, *Gen. Ins.*, fas. 152, p. 96.
1920. *Daphnephila*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 11.
1925. *Daphnephila*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 153.
1928. *Daphnephila*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 5.

This genus is recognised by its tri- or quadriarticulate palpi, bidentate and sub-apical terminal clasp segment and by its exserted, conical ovipositor with apical lobes or triangular plates. Kieffer (103) has described three species, *haasi*, *glandifex* and *lindrae*, from India. The location of types is not known.

Genotype.—Daphnephila hassi Kieff. (By original designation.)

Key to species.

I. Palpi triarticulate.
  A. Palpal segments equal . . . . . . *D. lindrae* Kieff.
  B. Palpal segments distinctly unequal . . . *D. haasi* Kieff.
II. Palpi quadriarticulate . . . . *D. glandifex* Kieff.

Tribe ITONIDIDINARIAE.

Sub-tribe *BIFILA*.

Genus **Indodiplosis** Felt.

1916. *Indodiplosis*, Felt, *Can. Entomol.*, XLVIII, p. 403.
1920. *Indodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 13.
1925. *Indodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 154.
1928. *Indodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 9.

This genus approaches *Erosomyia* Felt in its greatly lengthened wings and toothed claws on all legs but differs in its claws being unidentate. Only one species, *mangiferae*, has been described so far. It may be recognised by its eight circumfila loops.

Genotype.—Indodiplosis mangiferae Felt. (By original designation.)

Genus **Streptodiplosis** Felt.

1916. *Streptodiplosis*, Felt, *Can. Entomol.*, XLVIII, p. 405.
1920. *Streptodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 13.
1925. *Streptodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 154.
1928. *Streptodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 9.

This is a small genus related to *Lobopteromyia* Felt, which it resembles in its broad wings, but is distinguished by the stems of the male antennal segments being longer than twice their diameters and by its convolute heavily chitinised harpes. From *Indodiplosis* it may be distinguished by its simple claws. The palpi are quadriarticulate. Wings of male are broadly rounded posteriorly and the costa is not thickened basally.

Only one species, *indica*, has been described from Wynaad, South India. It is recorded to have been bred from an undetermined plant infested by the scale-insect, *Mytilapis piperis* Green, on which it is presumably predaceous.

Genotype.—*Streptodiplosis indica* Felt. (By original designation.)

Genus **Thurauia** Rubs.

1899. *Thurauia*, Rubsaamen, *Wein. Entomol. Zeit.*, XVIII, p. 58.
1913. *Thurauia*, Kieffer, *Gen. Ins.*, fas. 152, p. 175.
1925. *Thurauia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 155.

This genus has not been previously recorded from India. It resembles *Streptodiplosis* Felt in its simple claws and costa not thickened basally but differs in the length of its wing exceeding its breadth. Palpi quadriarticulate. Ovipositor greatly produced and chitinised. One new species is described below.

Genotype.—*Thurauia acquatica* Rubs. (By original designation.)

Thurauia chilkaensis, sp. nov.

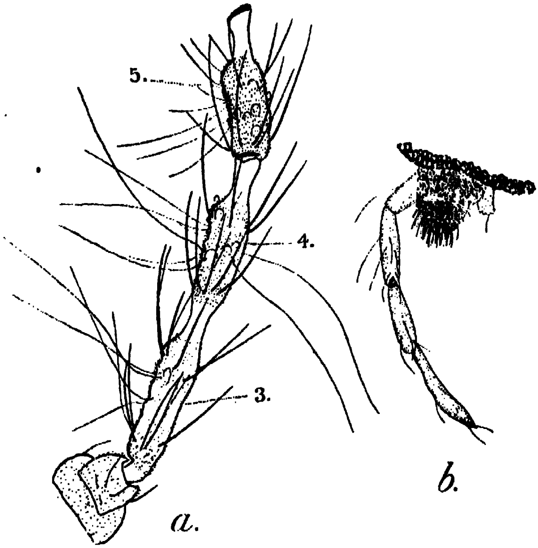
(Text-figs. 16 and 17.)

This new species is remarkable for its ovoviviparous habit, which has not previously been observed in adult gall midges.[1]

Female.— 2·5 mm. long. Body dark brown. Antennae half the length of body; segments 14; third and fourth segments fused, the former with a stem one-fourth the length of enlargement, which has a length four times its diameter, the latter segment three-fourths the length of third and with a stem one-half the length of enlargement; fifth segment with a stem three-fourths the length of enlargement, which latter has a length about twice its diameter; terminal segment with a length four times its diameter and with a constriction beyond the basal third. Palpi rather long, quadriarticulate; first segment with a length about four times its diameter; second segment one-half longer than first and nearly as stout; third segment as long as second, somewhat slender basally, sparsely setose; fourth segment one-third longer than third, reduced both basally and apically and sparsely setose. Mesonotum brown. Scutellum yellowish-brown. Claws simple and as

[1] Mani, M. S. *Current Science*, III, p. 109, (1934).

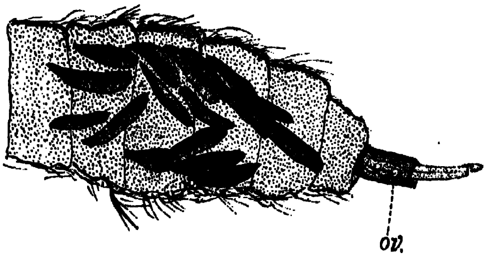
long as empodium. Abdomen yellowish and sparsely setose. Ovipositor about one-fourth the length of abdomen.



TEXT-FIG. 16.—*Thurauia chilkaensis*, sp. nov. *a.* antennal segments of female; *b.* palpus and mouth parts of female.

Holotype.— Female, on the same slide as the holotype of *Prolasioptera annandalei*, sp. nov., described above. No. $\frac{995}{H6}$.

Type-locality.— Barkuda Island, Chilka Lake, Madras Presidency, South India. Coll. N. Annandale.



TEXT-FIG. 17.—*Thurauia chilkaensis*, sp. nov. Abdomen of female showing living larvae hatched inside.

Life-history.— After the pairing of the midges, eggs are fertilised, but are not deposited. Larvae hatched from them are retained and

nourished inside the abdominal cavity of the mother. The maggots are deposited after about twelve days on decaying vegetable matter. When freshly extruded, they are about 1 mm. long and yellowish-white in colour. Some of them are already in a far advanced state of development and immediately pupate. Others, however, feed on the decaying vegetable matter and pupate after a further period of development extending over a month. The adults emerge in about five days.

Genus **Endaphis** Kieff.

1896. *Endaphis*, Kieffer, *Bull. Soc. Entomol. France*, p. 383.
1911. *Endaphis*, Felt, *Entomol. News*, XXII, p. 128.
1913. *Endaphis*, Kieffer, *Gen. Ins.*, fas. 152, p. 171.
1920. *Endaphis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 8.
1925. *Endaphis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 155.
1928. *Feltodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 8.
1928. *Endaphis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 8.

Senior-White regards *Endaphis* Kieff. as a synonym of *Feltodiplosis* Kieff. *Endaphis* Kieff. is a genus of the sub-tribe Bifila, while the latter belongs to the sub-tribe Trifila. They are therefore widely separated and are not related to each other. The type of the genus is not *Feltodiplosis abdominalis*, as given by Senior-White, but *Endaphis perfidus* Kieff.

The midges of this genus are distinguished from those of *Thurauia* Rubs. by the wings being neither too broad nor too narrow. Palpi quadriarticulate. First antennal segment with a conspicuous dorsal tooth. Costa thickly scaled and not thickened basally. Terminal clasp segment sub-cylindrical. Dorsal plate roundly bilobed and shorter than ventral plate. Lamellae of ovipositor thick and long.

Only one species of this genus, *hirta*, is described by Felt (37) from India. It is recorded to have been bred from the scale-insect, *Dactylopius* sp., on *Mimusopa hexandra* Roxb. and is likely to prove a possible control of the scale-insect.

Genus **Contarinia** Rond.

1860. *Contarinia*, Rondani, *Atti. Soc. Sc. Nat. Milano*, II, p. 287.
1894. *Eudiplosis*, Kieffer, *Bull. Soc. Entomol. France*, LXIII, p. 28.
1894. *Stictodiplosis* (*partim*), Kieffer, *Bull. Soc. Entomol. France*, LVIII, p. 28.
1896. *Contarinia*, Kieffer, *Wein. Entomol. Zeit.*, XV, pp. 94, 98-99.
1900. *Contarinia*, Kieffer, *Ann. Soc. Entomol. France*, XLIX, p. 447.
1908. *Contarinia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 390.
1913. *Contarinia*, Kieffer, *Gen. Ins.*, fas. 152, p. 178.
1918. *Contarinia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 93.
1920. *Contarinia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 270.
1925. *Contarinia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 155.
1928. *Contarinia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 10.

This genus is of considerable economic importance and includes many injurious species. *C. pyrivora* Rond., a European species introduced into America about 1877, is reported to be highly injurious to pear in the New York State. *C. johnsoni* Sling similarly causes occasionally severe injury to Moore Grapes in America. In India, *C. andropoginis* Felt is likely to prove a pest under favourable conditions. About forty species of this genus, of which two are from India, have been described so far.

This genus is distinguished from *Endaphis* Kieff. by its unscaled costa and untoothed first antennal segment. According to original description this genus is characterised by the sub-equal nodes of its antennal segments, its two whorls of uniform circumfila and by its third vein interrupting costa at the apex of wing. Palpi quadriarticulate. Pulvilli shorter than claws. Ovipositor apparently aciculate. Dorsal and ventral plates bilobed.

Genotype.—Contarinia loti Rond. (By original designation.)

Key to species.

I. Pulvilli nearly as long as the strongly curved claws, fifth antennal segment of male with stems equal to and one-half times greater than their diameters . *C. caudata* Felt.

II. Pulvilli nearly half the length of the slightly curved claws, fifth antennal segment with stems each one-quarter longer than their diameters . . . *C. andropoginis* Felt.

Contarinia caudata Felt.

1920. *Contarinia caudata*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 4.

This species is recorded to have been bred from ear-heads of *Apluda varia* Hack and *Andropogon schaemanthus* at Coimbatore, South Indio. I refer to this species a series of midges bred by me from galls on *Andropogon contortus* at Tanjore, South India. It is a reddish-brown midge about 2-2·5 mm. long., with the scutellum and post scutellum of male yellowish-brown. It is represented in Ramachandra Rao collection.

Contarinia andropoginis Felt.

1921. *Contarinia andropoginis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 25.

This species attacks the ear-head of *Andropogon sorghum* (*cholam*) in South India. I refer to this species four midges bred by me from *cholam* taken at the Borstal School Farm, Tanjore, South India. The midges are relatively smaller, dark or dark yellowish-brown with the scutellum also concolourous.

Genus **Stictodiplosis** Kieff.

1894. *Stictodiplosis*, Kieffer, *Bull. Soc. Entomol. France*, LXIII, p. 28.
1913. *Stictodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 183.
1920. *Stictodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 13.
1925. *Stictodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 155.
1928. *Stictodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 10.

This genus is closely related to *Contarinia* Rond., from which it is distinguished by its spotted wings. About a dozen species, mostly from Europe, have been described so far. One species, *pulcherima*, was described by Kieffer (106) from India.

Genotype.—Stictodiplosis nubilipennis Kieff. (By original designation.)

Genus **Procontarinia** Kieff. & Cecc.

1903. *Procontarinia*, Kieffer & Cecconi, *Marcellia*, V. p. 135.
1913. *Procontarinia*, Kieffer, *Gen. Ins.*, fas. 152, p. 183.
1920. *Procontarinia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 13.
1925. *Procontarinia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 155.
1928. *Procontarinia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 10.

This genus is also closely related to *Contarinia* Rond., from which it is distinguished by the basal triangular lobe on its basal clasp segment and by the semicircular ventral piece on its short ovipositor. The only species of this genus, *matteiana* Kieff. & Cecc., was described from India.

Genotype.—Procontarinia matteiana Kieff. & Cecc.

Genus **Dentifibula** Felt.

1907. *Contarinia (partim)*, Felt, *Bull. N. Y. St. Mus.*, 110, p. 132.
1908. *Dentifibula*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 389.
1911. *Dentifibula*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 51.
1913. *Dentifibula*, Kieffer, *Gen. Ins.*, fas. 152, p. 174.
1918. *Dentifibula*, Felt, *Bull. N. Y. St. Mus.*, No. 202, p. 129.
1920. *Dentifibula*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 13.
1925. *Dentifibula*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 157.
1928. *Dentifibula*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 9.

This genus was erected by Felt for midges closely related to *Contarinia* Rond., but differing in their triarticulate palpi and conspicuous, triangular apical process on their basal clasp segment. Third vein united with costa before the apex of wing. Claws simple, strongly curved and as long as pulvilli.

About half a dozen species, most of which appear to be zoophagous, have been described so far. Two species, *ceylanica* and *obtusilobae*, were described by Felt (58) from Ceylon.

Genotype.—Dentifibula viburni (Felt).

Genus **Myricomyia** Kieff.

1900. *Myricomyia*, Kieffer, *Ann. Soc. Entomol. France*, LXIX, p. 470.
1913. *Myricomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 185.
1925. *Myricomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 157.

This small genus, with only two species, has not been previously recorded from India. It is distinguished from *Dentifibula* Felt by the absence of apical triangular process on the basal clasp segment. Terminal clasp segment is stout and twice as long as its diameter. Ventral plate is truncate or nearly so. One new species is described below.

Genotype.—Myricomyia longipalpis Kieff. (By original designation.)

Myricomyia pongamiae, sp. nov.

(Text-fig. 18.)

This new species attacks the shoot of *Pongamia glabra* Vent. and gives rise to large, woody galls on them.

Male.— 2 mm. long. Body dark brown. Antennae lost. Palpi triarticulate; first segment short, sub-globose; second segment stout and with a length twice its diameter; third segment with a length about four times its diameter and basally as stout as the second and

apically reduced to an acutely pointed, cone-shaped tip; both the second and third segments with numerous long setae. Claws as long as pulvilli and slightly curved in fore-legs and shorter than pulvilli and sharply bent in mid and hind legs. Basal clasp segment boat-shaped and with a length about twice its breadth in the middle. Terminal clasp segment somewhat longer than twice its diameter and somewhat bent at the strongly chitinised apex. Dorsal plate shorter than ventral plate and deeply bilobed, lobes broadly elliptic.

Female.— 2·5 mm. long. Body dark brown, densely hairy. Antennae, half the length of body, segments 14; fifth segment with a stem one-third the length of enlargement, which latter has a length about thrice its diameter; terminal segment with a length over twice its diameter and with a prolongation one-third the length of enlargement. Palpi triarticulate; first segment with long setae; second segment sub-globose; third segment fusiform, with a length thrice its diameter, more slender than second and with a long slender setae apically. Mesonotum black, sub-median lines naked. Claws simple and a little longer than twice the length of empodium. Ovipositor retractile, one-fifth the length of body and sparsely clothed with long setae.

Text-fig. 18.—*Myricomyia pongamiae*, sp. nov. Solid stem galls of *Pongamia glabra* Vent.

Holotype.— Male, partly dissected on slide. No. $\frac{996}{H6}$.

Allo-co-types.— Three females on slide. No. $\frac{997}{H6}$.

Paratypes.— Both females and males in spirit. No. $\frac{1030}{H6}$.

Type-locality.— A scrub-jungle, near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 2.ii.1931.

Other localities.—Marina, Madras.

Galls.— The galls are local or extensive tumescence of branches, rachides and mid-ribs of leaves. They have not been described so far. 10-20 mm. in diameter. Regular, globose, pyriform, fusiform or irregular, extensive, moniliform, flexuose; greenish-yellow or brownish-yellow, glabrous when young and tubercular and punctate when old; solid, lignose, cystiferous and indehiscent. Cysts longitudinal. The epidermis surrounds a relatively large parenchymatous cortex of large cells. The cortex is separated from an inner medulla by the annular cystiferous zone, in which cysts and vascular bundles are arranged alternately. In older galls the medulla dries up leaving a large hollow space.

Life-history.— Eggs are laid on the tender shoots. The larvae hatching from them bore their way into the stem and, on reaching the vascular bundles, proceed either up or down. This occasions gall formation. The larval period is a long one and extends over two months. Pupation is in the galls just below the epidermis and takes about four or five days. There appear to be two generations in one year.

Sub-tribe *TRIFILA.*

Genus **Clinodiplosis** Kieff.

1894. *Clinodiplosis*, Kieffer, *Feuille Juenes Nat.*, XXIV, p. 121.
1896. *Clinodiplosis*, Kieffer, *Wein. Entomol. Zeit.*, XV, pp. 93; 96.
1911. *Clinodiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 54.
1913. *Clinodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 237.
1918. *Clinodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 202, pp. 177-179.
1920. *Clinodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Clinodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 162.
1928. *Clinodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 15.

This genus comprises about a dozen species. No adult form of this genus has as yet been described from India; but Kieffer (105) described three species, *nodifex*, *artemisiarum* and *cellularis*, from larval forms only.

Palpi quadriarticulate. Antennal segments 14, circumfila regular and not greatly produced. Claws toothed on fore and mid legs and simple on hind legs. Basal clasp segment not bilobed and without a spine. Terminal clasp segment fusiform and not dilated. Ventral plate elongate and apically emarginate. Dorsal plate deeply bilobed and triangularly emarginate.

Genotype.—*Clinodiplosis cilicrus* Kieff. (By original designation.)

Genus **Oribremia** Kieff.

1913. *Oribremia*, Kieffer, *Rec. Ind. Mus.*, IX, p. 199.
1913. *Oribremia*, Kieffer, *Gen. Ins.*, fas. 152, p. 194.
1920. *Oribremia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 14.
1925. *Oribremia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 162.
1928. *Oribremia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 11.

This genus is distinguished from *Clinodiplosis* Kieff. by its apically rounded ventral plate and deeply and narrowly divided dorsal plate.

The only species of this genus, *multifida*, was described by Kieffer (1913) from midges taken in the Kumaon Hills, Western Himalayas. The type location could not be traced.

Genotype.—Oribremia multifida Kieff.

Genus **Mycodiplosis** Rubs.

1853. *Diplosis (partim)*, Winnertz, *Linn. Entomol. Stett.*, VIII, p. 267.
1895. *Mycodiplosis*, Rubsaamen, *Entomol. Nachr.*, XXI, p. 186.
1896. *Mycodiplosis*, Kieffer, *Wein. Entomol. Zeit.*, XV, pp. 92-95.
1897. *Mycodiplosis*, Kieffer, *Synop. Cecid. Europ. Algerie*, p. 28.
1908. *Mycodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 400.
1910. *Mycodiplosis*, Rubsaamen, *Zeit. Wissenschaft. Insektenbiol.*, XV, p. 289.
1911. *Mycodiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 54.
1913. *Mycodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 241.
1918. *Mycodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 202, p. 179.
1920. *Mycodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Mycodiplosis*, Felt., *Bull. N. Y. St. Mus.*, No. 257, p. 162.
1928. *Mycodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

This genus comprises numerous small, light brown or yellowish midges, which breed on various fungi. The genus is recognised by the following characters: Palpi quadriarticulate; antennal segments 14, circumfila regular or nearly so, without greatly produced loops, middle circumfila of male not short; third vein united with costa beyond the apex of wing; claws unidentate on fore-legs and simple and slightly curved on mid and hind legs.

Genotype.—Mycodiplosis coniophaga (Winnertz). (By original designation.)

Mycodiplosis indica Felt.

1920. *Mycodiplosis indica*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 5.
1928. *Mycodiplosis indica*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

This is a small, reddish or reddish-brown midge breeding on spores of the rust fungus, attacking cambu, *Pennisetum typhoideum* Gertn. The antennae are twice the length of body in male and nearly as long as body in female. Mesonotum is thickly clothed with yellowish hairs in male. I refer to this species numerous maggots found on leaves of *cambu* with rust disease on the Borstal Farm, Tanjore, South India.

Genus **Schizobremia** Felt.

1926. *Schizobremia*, Felt, *Entomol. Month. Mag., London*, LXII, p. 183.
1928. *Schizobremia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

This genus appears to fall between *Mycodiplosis* Rubs. and *Diadiplosis* Felt. It resembles the former in its strongly curved, unidentate claws on fore and mid legs and simple claws on hind legs, but differs in its triarticulate palpi and third vein united with costa at the apex of wing. It resembles the latter in its triarticulate palpi but differs in its strongly bent claws and relatively longer ventral plate. Only two species, of which one is Indian, have been described so far.

As no genotype has so far been indicated, I designate *S. formosana* Felt as the type of the genus *Schizobremia* Felt.

Schizobremia malabarensis Felt.

1927. *Schizobremia malabarensis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, X, pp. 1-2.

This is a small yellowish midge with the antennae about three-fourths the length of body. It breeds on the mealy bug, *Pseudococcus virgatus*, in South Malabar. Felt provisionally referred the midge to this genus.

Genus **Diadiplosis** Felt.

1911. *Diadiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 54.
1913. *Diadiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 240.
1918. *Diadiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 202, p. 204.
1920. *Diadiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 14.
1925. *Diadiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 162.
1928. *Diadiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 16.

This genus was erected by Felt for midges closely related to *Mycodiplosis* Rubs., but with triarticulate palpi. Claws are not sharply bent. Terminal clasp segment is not greatly produced. Ventral plate short and broad.

Of the two Indian species, *coccidivora* Felt, was described from Ceylon. The species, *indica* Felt, was taken at Pusa. It breeds on the scale-insects, *Phenococcus hirsutus* of Mulberry and *Pseudococcus corymbatus*.

The genotype is *D. cocci* Felt and not *D. coccidivora* Felt, as given by Senior-White.

Key to species.

I. Circumfila loops 8, stems of fifth antennal segments equal, abdomen yellow	*D. coccidivora* Felt.
II. Circumfila loops 10, stems of fifth antennal segments unequal, abdomen reddish-brown	*D. indica* Felt.

Genus **Xiphodiplosis** Felt.

1915. *Xiphodiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XXIII, p. 180.
1920. *Xiphodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Xiphodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 162.
1928. *Xiphodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 17.

This genus is related to *Diadiplosis* Felt, from which it is distinguished by its greatly produced terminal clasp segment being equal to the basal clasp segment. Ventral plate is longer than dorsal plate, moderately broad and rounded apically. Palpi triarticulate. The only species of this genus, *fulva*, is described by Felt from Ceylon.

Genotype.—Xiphodiplosis fulva Felt.

Genus **Arthrocnodax** Rubs.

1895. *Arthrocnodax*, Rubsaamen, *Wein. Entomol. Zeit.*, XIV, p. 189.
1896. *Arthrocnodax*, Kieffer, *Wein. Entomol. Zeit.*, XV, p. 92.
1897. *Arthrocnodax*, Kieffer, *Synop. Cecid. Europ. Algerie*, pp. 29.
1908. *Arthrocnodax*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 403.
1911. *Arthrocnodax*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 57.
1913. *Feltodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 154.
1913. *Arthrocnodax*, Kieffer, *Gen. Ins.*, fas. 152, p. 155.
1920. *Feltodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 12.
1925. *Arthrocnodax*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 163.
1928. *Arthrocnodax*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 8.

This genus comprises numerous small, yellowish midges, with a zoophagous habit. It is distinguished from *Xiphodiplosis* Felt by its simple claws on all legs. Palpi quadriarticulate. Antennal segments with lengths less than their diameters and with short circumfili. Third vein united with costa before the apex of wing. Pulvilli as long as claws. Felt believes *Feltodiplosis* Kieff. to be identical with *Arthrocnodax* Rubs. Two species, *ruthurfordi* and *walkeriana*, were described by Felt (36) from Ceylon.

Genotype.—Arthrocnodax vitis Rubs. (By original designation.)

Genus **Microdiplosis** Tav.

1908. *Microdiplosis*, Tavares, *Broteria*, VII, p. 155.
1913. *Microdiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 210.
1925. *Microdiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 163.

This genus, not previously recorded from India, comprises minute midges breeding in galls of Acarina. It is related to *Arthrocnodax* Rubs., which it resembles in its simple claws on all legs, quadriarticulate palpi and pulvilli equal to claws, but differs in the relatively longer stem of its flagellate antennal segments and relatively longer circumfila. Third vein united with costa near or at the apex of wing. Ventral plate slender, emarginate, apically enlarged and longer than dorsal plate. Kieffer (111) describes the pulvilli as rudimentary but I find them well developed, though short.

Genotype.—Microdiplosis zambensis Tav. (By original designation.)

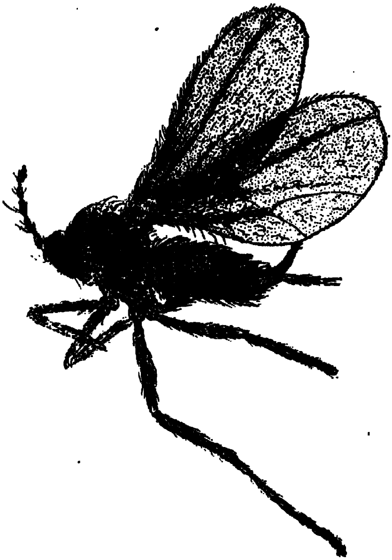
Microdiplosis pongamiae, sp. nov.

(Text-figs. 19 and 20.)

This species was bred from the polypoid galls on the leaflets of *Pongamia glabra* Vent. along with the mite, *Eriophyes cheriani* Massee. I refer to this species a series of midges bred by Annandale from the polypoid galls taken at Chilka Lake and now in the collection of the Zoological Survey, Indian Museum.

Male.— 1 mm. long. Body yellowish. Antennae one-fourth longer than body; segments 14; first segment broadly obpyriform, deeply excavated apically, with a length three-fourth its diameter; second segment irregularly sub-globose, with a length a little greater than its diameter; third segment with the apical enlargement stouter than the basal, stems sub-equal; fourth segment united with third and a little longer, basal stem with a length about one half the diameter of the basal enlargement, apical stem with a length over one half the diameter of the apical enlargement; fifth segment sub-equal to third, apical enlargement lengthened-out both basally and apically, stems sub-equal. Palpi quadriarticulate; second segment short, globose; third segment ovoid, one and half times as long as second and equally stout; fourth segment twice the third. Mesonotum yellowish-brown. Claws simple on all legs, somewhat sickle-shaped, about as long as empodium. Basal clasp segment irregularly triangular, with a length about twice its breadth at the base. Terminal calsp segment swollen basally, slightly and

evenly curved distal portion with a length five times its diameter, minutely bidentate at apex.



TEXT-FIG. 19.—*Microdiplosis pongamiae*, sp. nov. Female showing the head partially covered over by the thorax.

Female.— 0·75 mm. long. Body dirty yellowish-brown, thickly haired. Antennae three-fourths the length of body; segments 14; second segment ovoid, with a length one half greater than its diameter; third segment fused with the fourth, with a stem one-fifth the length of the cylindrical enlargement, which latter has a length two and half times its diameter; fourth segment a little shorter than third and with a stem one-fourth the length of enlargement; fifth segment a little shorter than fourth, with a stem one-half the length of the enlargement; stems of other flagellate segments gradually increase in length; stem of penultimate segment transparent, one-third the length of the enlargement. Palpi quadriarticulate; first segment short, ovoid; second and third segments sub-equal, each with a length about four times its diameter; fourth segment a little shorter and more slender than third. Mouth parts somewhat prolonged. Thorax distinctly produced over the head. Mesonotum dark brown. Claws bent at right angles, with rudimentary pulvilli. Ovipositor long, partially retractile; terminal lobes with a length three times the breadth.

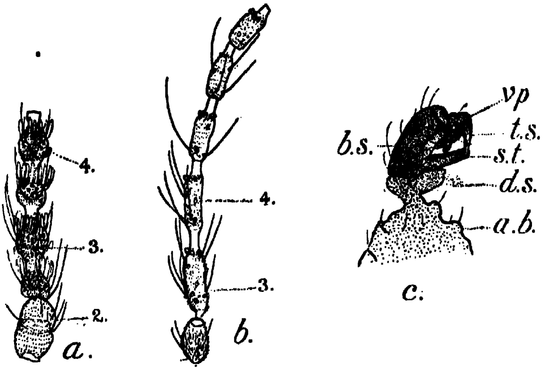
Holotype.— Male, in spirit. No. $\frac{998}{H\ 6}$.

Allotype.— Female, on slide. No. $\frac{999}{H\ 6}$.

Paratypes.— Both males and females, in spirit. No. $\frac{1000}{H 6}$. On slides Nos. $\frac{1001}{H 6}$ and $\frac{1031}{H 6}$.

Homotypes.— (N. Annandale coll.) in spirit. No. $\frac{1002}{H 6}$.

Type-locality.— A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 17.vii.1933.



TEXT-FIG. 20.—*Microdiplosis pongamiae*, sp. nov. *a.* antennal segments of male; *b.* antennal segments of female; *c.* male genitalia; *a. b.* abdomen; *b. s.* basal clasp segments; *d. s.* dorsal segment; *s. t.* style; *t. s.* terminal segment; *v. p.* ventral plate.

Other localities.— Coimbatore, Vellore, Madras, Chilka Lake Islands, and Calcutta.

Galls.— The polypoid galls were believed by Cherian to be produced by the mite, *Eriophyes cheriani* Massee. Further investigations (126), however, have shown that both this mite and the new species of midge described above are responsible for its formation. Neither of them alone produce such galls.

10 mm. long, 5 mm. thick. Regular, obovoid or obliquely obpyriform, polyp-like, hollow, pedicelled galls on the upper surface of the leaflets. Simple or compound, unilocular, acystiferous and indehiscent. Cavity communicates with the outside by a narrow passage through the pedicel. Greenish or dark-greenish, glabrous or rarely pubescent or tomentose on the outside and with numerous granulations and erineums on the inner side. Palisade and spongy parenchymae of leaflets completely degenerated into broad, horse-shoe shaped, undifferentiated parenchyma. There is an apparent increase of vascular bundles and fibrous tissues in the gall.

Life-history.—Not known in detail. Earlier stages not studied. Larvae live in company with the mites and feed on the plant tissues. Pupal period is variable with seasons, occupying only about three days in dry weather and more than a week in wet weather. There are apparently many generations in one year.

Genus **Cecidomyiella** Del Guer.

1918. *Cecidomyiella*, Del Guerico, *Bibl. Agr. Cologna*, p. 247.
1925. *Cecidomyiella*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 103.

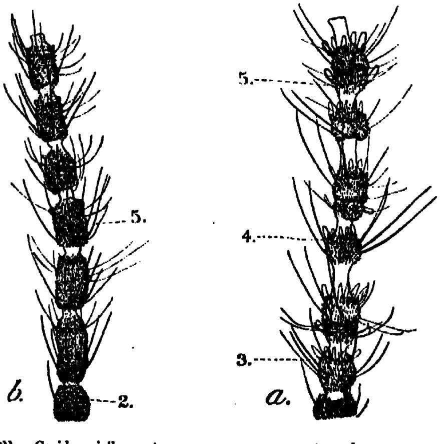
I am recording this genus for the first time from India. It is closely related to *Microdiplosis* Tav., from which it is distinguished by the relatively longer stems of its flagellate antennal segments. The lobes of the divided dorsal plate are long, triangular and shorter than ventral plate. The new species described below is referred to this genus.

Cecidomyiella crataevae, sp. nov.

(Text-figs. 21 and 22, plate VII, figs. 4 and 5.)

This new species produces leaf-bud galls on *Crataeva religiosa* Forst.

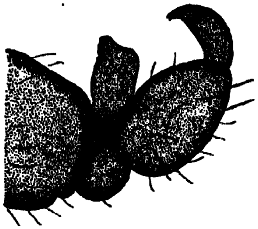
Male.—1·25 mm. long. Body yellowish-brown. Antennae a little longer than body, segments 14 ; third segment fused with the fourth, stems one-fourth and three-fourths the length of basal and apical enlargements respectively, apical enlargement somewhat constricted about its basal fourth ; fourth segment with stems one-third and three-fifths the enlargements, basal enlargement sub-globose, apical enlargement sub-cylindrical, slightly constricted in the middle, with a length over one half greater than its diameter ; ninth segment with stems equal to and three-fourths the enlargements ; terminal segment with a stem a little longer than basal sub-globose enlargement, apical enlargement



TEXT-FIG. 21.—*Cecidomyiella crataevae*, sp. nov. *a*. antennal segments of male ; *b*. antennal segments of female.

distinctly swollen in the middle. Palpi quadriarticulate ; first segment very short, stout ; second segment stout, cylindrical and with a length twice its diameter ; third segment one-half longer and more slender than second ; fourth segment sub-equal to third and sparsely setose.

Mesonotum brown. Claws simple and as long as pulvilli. Basal clasp segment broadly and roundly triangular, with a length a little less than twice the breadth and sparsely setose. Terminal clasp segment short, stout, slightly curved, strongly chitinised and bidentate apically. Dorsal plate with a rounded apex, emarginate and longer than the ventral plate.



TEXT-FIG. 22.—*Cecidomyiella crataevae*, sp. nov. Male genitalia.

Female.— 1 mm. long. Body bright orange. Antennae as long as body, segments 14, with a basal whorl of long and an apical whorl of shorter setae ; third segment with a stem one-seventh the length of the cylindrical enlargement, which latter has a length twice its diameter ; fifth segment with a stem about one-fourth the length of enlargement, which latter has a length one-fourth greater than its diameter ; terminal segment with a length four times its diameter and somewhat reduced towards the apex. Palpi quadriarticulate ; first and second segments short and slender ; third segment a little longer and stouter ; fourth segment very stout and much longer than the rest, sparsely covered with short setae. Pulvilli longer than claws in fore-legs and as long as claws in hind legs. Ovipositor half the length of body.

Cotypes.— Males and females, partly dissected on slides. Nos. $\frac{1008}{\text{H 6}}$ and $\frac{1032}{\text{H 6}}$.

Paratypes.— Males and females in spirit. No. $\frac{1033}{\text{H 6}}$.

Type-locality.— A scrub-jungle near Tanjore, Madras Presidency, South India. Coll. M. S. Mani, 7.vii.1933.

Other localities.— Medical College Grounds, Madras.

Galls.— The galls are homologically leaf buds, leaflets or out-growths from the cortex of the shoot.

5-15 mm. in diameter. Irregular, globose or pyriform, local or extensive, free or compound ; lobed, solid, fleshy, succulent, tubercular, yellowish-green or yellowish-white on the surface and greenish within, with narrow irregular spaces. When cut, the gall presents the appearance of a ruminated endospermous seed. Larvae are found in the spaces between the lobes. The substance consists entirely of simple parenchyma with all the veins intact and scattered in the parenchyma. Centres of cell proliferation are parenchyma of leaves and cortex of young stems.

Life-history.— Eggs are laid on the tender leaf buds and maggots hatch out on the second or the third day. They attack the developing

buds and thus occasion the formation of galls. Larval period is about two weeks, at the end of which the scarlet-red maggots creep out of the gall and wander on the surface of the plant for a time and finally drop to the ground. They burrow into the soil to a depth of about one to two inches, where they pupate in small oval, silken-lined chambers. At this time they appear to be very sensitive to light, as any exposure retards their development. Pupal period takes about three days, at the end of which the adults escape from the soil. There are several generations in the year.

Genus **Chrysodiplosis** Kieff.

1911. *Chrysodiplosis*, Kieffer, *Trans. Linn. Soc., London*, XIV, p. 318.
1913. *Chrysodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 145.
1920. *Chrysodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 12.
1925. *Chrysodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 163.
1928. *Chrysodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 7.

This genus is recognised by its quadriarticulate palpi, finely denticulate antennal hairs and dense yellowish hairs on the thorax. Wings rather densely brown-haired, with clear spots, costa scaled black, third vein united with costa before the apex of wing. Claws simple on all legs.

Genotype.—Chrysodiplosis pulchericornis Kieff.

Chrysodiplosis squamatipes Kieff.

1912. *Chrysodiplosis squamatipes*, Kieffer, *Spol. Zeyl.*, VIII, p. 28.
1920. *Chrysodiplosis squamatipes*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 12.

I refer to this species one badly damaged midge in the Indian Museum collection bearing the label: Peradeniya, Ceylon. It is presumably one of the paratypes mentioned by Brunetti.

Genus **Plutodiplosis** Kieff.

1912. *Plutodiplosis*, Kieffer, *Spol. Zeyl.*, VIII, p. 27.
1913. *Plutodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 166.
1920. *Plutodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 12.
1925. *Plutodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 164.
1928. *Plutodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 9.

This small genus is distinguished from *Chrysodiplosis* Kieff. by its third vein united with costa beyond the apex of wing and by its one or more produced loops of circumfila. Palpi quadriarticulate. Wings yellow with black spots. Legs thickly scaled and spotted. Pulvilli as long as claws. The only species of this genus, *magnifica*, was described by Kieffer (109) from Ceylon.

Genotype.—Plutodiplosis magnifica Kieff. (By original designation.)

Genus **Raodiplosis** Felt.

1920. *Raodiplosis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 6.
1925. *Raodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 165.
1928. *Raodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 14.

This genus was erected by Felt for midges bred by A. G. Rao from Mango in Thaton, Burma. It is related to *Caryomiya* Felt and *Macrodiplosis* Kieff., but differs in its very narrow wings, having a length four

times its breadth, in the relatively longer stem of its flagellate segments and in its ovipositor having a length one-third that of the abdomen. Only one species, *orientalis*, has been described so far.

Genotype.—Raodiplosis orientalis Felt. (By original designation.)

Genus **Androdiplosis** Felt.

1915. *Androdiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XXIII, p. 182.
1920. *Androdiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 16.
1925. *Androdiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 165.
1928. *Androdiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 15.

Basal flagellate antennal segments of female plainly binodose. Pulvilli as long as claws. Ovipositor short and without a conspicuous process on the lobes.

The only species of this genus, *coccidivora*, was described by Felt from Ceylon, and the description is based on a female specimen.

Genus **Diplecus** Kieff.

1912. *Coprodiplosis (partim)*, Kieffer, *Spol. Zeyl.*, VIII, p. 29.
1913. *Diplecus*, Kieffer, *Bull. Nat. Hist. Soc. Metz*, XXVII, p. 55.
1913. *Diplecus*, Kieffer, *Gen. Ins.*, fas. 152, p. 201.
1920. *Diplecus*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 14.
1925. *Diplecus*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 165.
1928. *Diplecus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 11.

This genus is distinguished from *Androdiplosis* Felt by its rudimentary pulvilli. The type in the Indian Museum is badly damaged.

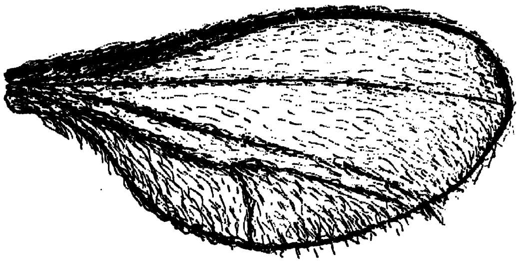
Genotype.—Diplecus inconspicuus (Kieff.). (By original designation.)

Diplecus inconspicuus (Kieff.).

(Text-fig. 23.)

1912. *Coprodiplosis inconspicuus*, Kieffer, *Spol. Zeyl.*, VIII, p. 29.
1913. *Diplecus inconspicuus*, Kieffer, *Bull. Nat. Hist. Metz*, XXVII, p. 55.

This is a small reddish coloured species described from Ceylon. Fragments of a single midge, apparently a paratype, were found with



TEXT-FIG. 23.—*Diplecus inconspicuus* (Kieff.). Wing of male.

the label: *Coprodiplosis inconspicuus* Kieff., Peradeniya, Ceylon, Ind. Museum. In order to prevent its further deterioration, I have mounted

it in Canada balsam (Slide No. $\frac{1004}{H\,6}$). Female 1 mm. long. Claws short and without a distinct empodium.

Genus **Orseoliella** Kieff.

1909. *Orseolia (partim)*, Kieffer and Massalongo, *Marcellia*, VIII, p. 125.
1912. *Orseoliella*, Kieffer, *Marcellia*, XI, p. 231.
1913. *Orseoliella*, Kieffer, *Gen. Ins.*, fas. 152, p. 152.
1920. *Orseoliella*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 15.
1925. *Orseoliella*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 167.
1928. *Orseoliella*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 7.

This genus is distinguished from *Orseolia* Kieff. and Mass., to which it is related, by its quadriarticulate palpi and five loops of circumfila on the flagellate antennal segments of female. Third vein united with costa beyond the apex of wing. Claws simple on all legs and not sharply bent at right angles. Pulvilli a little longer than claws. Basal clasp segment lobed, lobes basal and obtuse. Ventral plate long, broad and broadly rounded apically.

Genotype.—Orseoliella javanica (Kieff.). (By original designation.)

Key to species.

I. Antennae three-fourths the length of body, pulvilli a little longer than claws . . . . *O. apludae* Felt.
II. Antennae as long as body, pulvilli as long as claws . *O. graminis* Felt.

Orseoliella apludae Felt.

1920. *Orseoliella apludae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 8.

This is a large midge which breeds in galls of the grass, *Apluda varia* Hack. Mesonotum reddish-brown in both sexes. Abdomen yellowish in male and reddish-brown in female.

Orseoliella graminis Felt.

1921. *Orseoliella graminis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 22.

This is a slightly larger species than the above. It gives rise to galls on *Andropogon squarosus* Linn.

Genus **Lestodiplosis** Kieff.

1884. *Lestodiplosis*, Kieffer, *Bull. Soc. Entomol. France*, LXIII, p. 280.
1894. *Coprodiplosis*, Kieffer, *Fuelle Jeunes Nat.*, XXIV, p. 84.
1894. *Hemidiplosis*, Kieffer, *Ann. Sc. Nat.*, I, p. 9.
1908. *Lestodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 407.
1910. *Lestodiplosis*, Rubsaamen, *Zeit. Wissen. Insektenbiol.*, XV, p. 285.
1911. *Lestodiplosis*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, pp. 59-60.
1913. *Lestodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 195.
1920. *Lestodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 14.
1925. *Lestodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 167.
1928. *Lestodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 11.

This genus comprises numerous small to medium-sized, yellowish or brownish, zoophagous midges. They feed on the larvae of other

Itonids, Mycetophilids, Xylophagids, etc. A number of species are also inquilines in different midge galls.

The genus is recognised by the triangular lobe at the base of the slender basal clasp segment. Dorsal plate short, deeply and triangularly emarginate, lobes narrow, parallel and broadly rounded. From the typical *Lestodiplosis* Kieff. the sub-genus *Coprodiplosis* Kieff. is separated by its hyaline wings, which, however, is not a reliable character.

One species of this genus,, *ceylanicus*, was described by Kieffer (109) from Ceylon.

Genotype.—Lestodiplosis alternans Kieff. (By original designation.)

Genus **Pachydiplosis** Kieff.

1913. *Pachydiplosis*, Kieffer, *Bull. Nat. Hist. Soc. Metz.*, XXVIII, p. 108.
1913. *Pachydiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 224.
1920. *Pachydiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 15.
1925. *Pachydiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 160.
1928. *Pachydiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 14.

Felt (76) places this genus between *Plemeliella* Sitn. and *Itonida* Meig. in the series with dorsal plate not incised. I find, however, that this genus more closely approaches *Styracodiplosis* Tav. (172) in its deeply and roundly incised dorsal plate, with broadly rounded lobes and in its moderately short, stout, terminal clasp segment but differs in the same not being dentate or serrate. The genus would thus be more correctly placed with *Styracodiplosis* Tav.

Pachydiplosis is distinguished from *Lestodiplosis* Kieff. by its unspotted wings and basal clasp segment not conspicuously lobed. It is distinguished from *Itonida* Meig. by its relatively shorter terminal clasp segment, longer conical ovipositor and by the dorsal plate.

About half a dozen species, most of them previously referred to *Clinodiplosis* Kieff., have been described so far. Kieffer described two Indian species.

Genotype.—Pachydiplosis apricanus Kieff. (By original designation.)

Partial key to species.

I. Pulvilli shorter than claws . . . . . *P. oryzae* (Wood-Mason) Mani.
II. Pulvilli as long as claws . . . . . *P. ceylanicus* (Kieff.).

Pachydiplosis oryzae (Wood-Mason) Mani.

(Text-figs. 24, 25 and 26.)

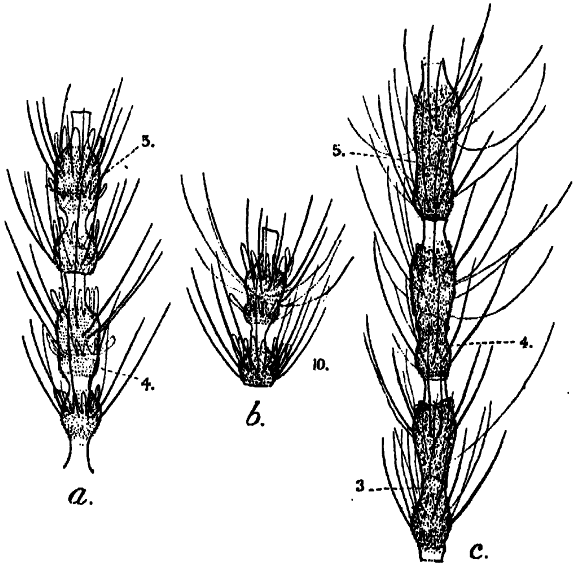
1881. *Cecidomyia oryzae*, Wood-Mason in Riley, *Amer. Naturalist*, p. 149.
1890. *Cecidomyia oryzae*, Cotes, *Ind. Mus. Notes*, I, p. 103.
1921. *Pachydiplosis oryzae*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 16.
1928. *Pachydiplosis oryzae*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 14.

This midge was first observed on paddy by Wood-Mason (187), who proposed for it the name *Cecidomyia oryzae*, but published no description. Subsequently Felt (72) identified the midge bred from the "silver-shoot" galls of paddy at Coimbatore as belonging to the genus *Pachydiplosis* Kieff. and assuming that it was identical with Wood-Mason's *Cecidomyia oryzae*, called it *Pachydiplosis oryzae* (Wood-Mason),—but

did not publish any description. I describe the midge below, and have retained the name in view of the fact that it is well-known to workers on this group.

The following description is based on midges in Ramachandra Rao's collection, kindly placed at my disposal by Dr. T. V. Ramakrishna Ayyar, Government Entomologist, Agricultural College and Research Institute, Coimbatore.

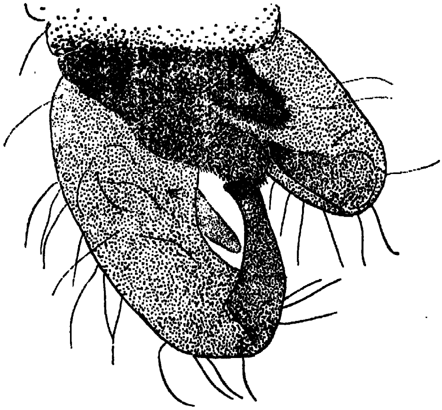
Male.— 3 mm. long. Body yellowish-brown, sparsely haired. Antennae dark reddish-brown, thickly haired, nearly equal in length to the body, segments 14 ; third segment with stems one-fifth and one-half the lengths of the basal and apical enlargements, basal enlargement broadly ovoid, with a length nearly equal to its diameter, apical enlargement sub-globose, with a length about twice its diameter ; fourth segment fused with third, sub-equal, stems one-fifth and one-half the basal globose and apical sub-cylindrical enlargements ; fifth segment a little shorter than fourth, stems two-thirds and one-half the basal and apical enlargements ; tenth segment with a basal stem three-fourths the length of basal globose enlargement and with an apical stem two-thirds the length of the apical sub-cylindrical enlargement, which latter is conspicuously constricted at its basal one-third ; penultimate segment with a basal stem sub-equal to the basal globose enlargement and an apical



TEXT-FIG. 24.—*Pachydiplosis oryzae* (Wood-Mason) Mani. *a.b.* antennal segments of male ; *c.* antennal segments of female.

stem one-half the length of apical enlargement, which latter is distinctly stouter apically than basally and has a length about twice its diameter ;

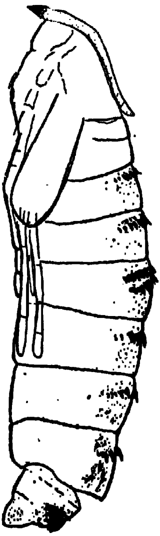
terminal segment sub-cylindrical, with a length twice its diameter and with a prolongation a little less than half its length. Palpi quadriarticulate, short, sparsely setose; first segment short, stout, broader than long; second segment nearly as long as first but more slender; third segment a little longer and more slender than second; fourth segment nearly equal to third, somewhat stouter and less setose, tip broadly and evenly rounded. Mesonotum brown, sub-median lines sparsely haired. Scutellum dirty yellowish-brown, post-scutellum darker. Halteres, stem light yellowish, head greyish-brown. Legs densely hairy and dark brown. Claws simple on all legs, evenly and slightly curved. Pulvilli half the length of claws. Abdomen brownish-yellow, sparsely setose. Genitalia pale brown, somewhat thickly setose; basal clasp segment with a breadth at the base half the length and a breadth at the apex one-fourth the length, swollen basally and moderately setose; terminal clasp segment about half the length of the basal clasp segment, rather thickly swollen at the base, somewhat curved beyond the basal half, sparsely setose and strongly chitinised apically; dorsal plate deeply and broadly bilobed, lobes reddish-brown, thickly and shortly setose, with a length twice the breadth, evenly and broadly rounded apically.



TEXT-FIG. 25.—*Pachydiplosis* (Wood-Mason) Mani. Male genitalia.

Female.— 3·5 mm. long. Body bright reddish-brown, thickly haired. Antennae dark brown, moderately thickly haired, about half the length of body, segments 14; third segment with a stem one-ninth the sub-cylindrical, distinctly binodose enlargement; fourth segment about three-fourth the length of third, with which it is fused, stem one-sixth the length of enlargement, which latter is constricted at its basal one-fourth; fifth segment nearly equal to fourth, stem about one-quarter the length of enlargement; ninth segment with a stem about one-third the length of the cylindrical enlargement, which latter has a length

about two and half times its diameter. Palpi quadriarticulate, sparsely setose; first segment short, stout; second segment with a length four times its diameter; third nearly equal to second; fourth stouter and a little longer than third, broadly and evenly rounded apically. Mesonotum dull reddish-brown at the sides and brownish-black between the sub-median lines, which are thickly haired. Scutellum reddish-brown, post-scutellum dark reddish-brown. Legs brownish and sparsely setose. Claws simple on all legs, diverging and somewhat curved at very tip only. Pulvilli half the length of claws but project beyond them. Abdomen bright reddish-brown in fresh and dark reddish-brown in older specimens, moderately setose. Ovipositor short, conical, terminal lobes of lamellae with a length two and half times its greatest width, sparsely setose.



TEXT-FIG. 26.—*Pachydiplosis* (Wood-Mason) Mani. Exuvium of female showing a transverse row of spines on the dorsum of the abdomen.

Exuvium of female.— 5 mm. long. Antennal horns (cephalic horns) strongly chitinised and acutely pointed but not serrate anteriorly. Wing cases touch the posterior margin of the second abdominal segment. Hind legs reach but do not touch the posterior margin of the fifth abdominal segment. Dorsum of abdomen with transverse rows of stout, short, posteriorly recurved, strongly chitinised spines near the anterior margin. Dorsum of first segment without spines; second segment with an anterior rudimentary and a posterior well-developed row;

third segment with two well-developed rows of alternating spines; rest of the segments up to the last but one similar; the penultimate segment with spines longer, more slender and more acutely curved than on all the other segments. Spines on the sides of the segment shorter than those on the middle.

Holotype.— Male, partly dissected on slide. No. $\frac{1005}{H\,6}$.

Allotype.— Female, partly dissected on slide. No. $\frac{1006}{H\,6}$.

Paratypes.— One male and one female on pins. Nos. $\frac{1007}{H\,6}$ and $\frac{1008}{H\,6}$.

Type-locality.— Coimbatore, Madras Presidency, South India, Coll. Y. R. Rao, 28.vii-9.viii. 1916.

Remarks.— This midge gives rise to long, tusk-shaped, white or pale brown, hollow galls on the shoot of the paddy plant and prevents the formation of the earheads; it is the cause of the disease popularly called *anakomban*. The damage is often very extensive. It occurs almost throughout South India and to some extent in Bengal. The Proctotrypid parasite, *Platygaster oryzae* Cam. (Hymenoptera) sometimes effectively checks the spread of this pest, but no really effective control measure is known. The grass *Ophiurus corymbosus* is supposed to be an alternative food plant for this midge. Cotes (16) records that Wood-Mason believed this midge to be ovoviviparous.

Pachydiplosis ceylanicus (Kieff.).

1902. *Clinodiplosis ceylanicus*, Kieffer, *Spol. Zeyl.*, VIII, pp. 26-27, fig. 3.
1913. *Pachydiplosis ceylanicus*, Kieffer, *Gen. Ins.*, fas. 152, p. 224.
1928. *Pachydiplosis ceylanicus*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 14.

This is a somewhat smaller species of brownish-red colour. It was described by Kieffer from Ceylon. The type is lost. Five very badly damaged females, apparently paratypes, were found in the Indian Museum with the label: *Clinodiplosis ceylanicus* Kieff., Peradeniya, Ceylon, 3-x-10. To prevent further deterioration, I have mounted them in Canada balsam (Slide No. $\frac{1009}{H\,6}$).

According to Kieffer, this species is related *P. graminicola* (Kieff.), which has been recorded from South India and Ceylon.

Genus **Itonida** Meig.

1800. *Itonida*, Meigen, *Nouvelle Classification*, p. 19.
1803. *Cecidomyia*, Meigen, *Illeger's Magazine*, II, p. 261.
1850. *Diplosis*, Herman Loew, *Dipt. Beitr.*, IV, p. 20.
1862. *Diplosis*, Osten Sacken, *Mon. N. American Dipt.*, I, p. 76.
1895. *Cryptodiplosis*, Kieffer, *Bull. Soc. Entomol. France*, LXIV, p. 194.
1897. *Diplosis*, Kieffer, *Synop. Cecid. Europ. Algerie*, p. 41.
1908. *Cecidomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 412.
1908. *Itonida*, Hendel, *Verhandl. zool-bot. Ges. Wein.*, LVIII, p. 49.
1910. *Cecidomyia*, Rubsaamen, *Zeit. Wiss. Insekt.*, XV, p. 286.
1911. *Itonida*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 61.
1913. *Cecidomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 211.
1913. *Itonida*, Kieffer, *Gen. Ins.*, fas. 152, p. 258.
1920. *Cecidomyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 15.
1921. *Itonida*, Felt, *Bull. N. Y. St. Mus.*, Nos. 231, 232, pp. 175-208.
1925. *Itonida*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 169.
1928. *Cecidomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 13.
1928. *Itonida*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 17.

This is the oldest genus of the family and was erected by Meigen in 1800. At first it included all the other genera now referred to the

family. As at present recognised, it comprises over fifty two species, most of which are American. It is believed that the midges of this genus breed in leafy tissues. Two species have been described so far from India.

This genus is related to *Pachydiplosis* Kieff. but is distinguished by its terminal clasp segment equal to basal clasp segment and by its relatively longer, lobed ovipositor. Felt (73a) summarises the characters of this genus as follows: Palpi quadriarticulate; antennal segments 14, flagellate antennal segments of male binodose, nodes distinctly unequal, circumfila well developed; sub-costa united with costa before the basal third; third vein united with the margin of wing well beyond the apex, fifth vein united with posterior margin of wing at the basal third, costa interrupted behind its union with the third vein; claws simple on all legs and shorter than pulvilli; dorsal and ventral plates rather deeply bilobed; ovipositor long and stout, with long, narrowly oval terminal lobes, distinctly contracted basally.

Genotype.—Itonida pini (De Geer).

Key to species.

I. Antennae as long as body in female and one half longer than body in male, fifth antennal segment of female with stem three-fourths the length of enlargement . . . . *I. penniseti* Felt.

II. Antennae shorter than body in female and as long as body in male, fifth antennal segment of female with stem one-third the length of enlargement . . *I. seminis* Felt.

Itonida penniseti Felt.

1920. *Itonida penniseti*, Felt, *Mem. Dept. Agric. Ind., Entompl. Ser.*, VII, p. 9.

This is a medium-sized midge attacking the grasses *Pennisetum cenchroides* Rich. and *P. alopecuros* Steud. Male abdomen yellowish, first segment reddish-brown. Female abdomen brown. I refer to this species numerous midges found breeding in *P. cenchroides* Rich. at Tanjore.

Itonida seminis Felt.

1921. *Itonida seminis*, Felt, *Mem. Dept. Agric. Ind., Entomol Ser.*, VII, p. 26.

This species attacks the ear-heads of *Pennisetum typhoideum* Gertn. (*cambu*). The female of this species is somewhat larger than that of the preceding species. The abdomen is orange coloured. This species is likely to prove a serious pest under favourable conditions.

Genus **Xylodiplosis** Kieff.

1853. *Diplosis (partim)*, Winnertz, *Linn. Entomol. Stett.*, VIII, p. 276.
1895. *Xylodiplosis*, Kieffer, *Bull. Soc. Entomol., France*, LXIV, p. 193.
1913. *Xylodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 226.
1925. *Xylodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 169.

I am recording this genus here for the first time from India. It is referable to the tribe Porricondylariae but is provisionally placed in the Itonididinariae by Felt. Kieffer based the description of the genotype on the male only, the female being unknown. I have come

across both sexes of another new species of this genus from Castle Rock, which I describe below under the name *X. kempi.*

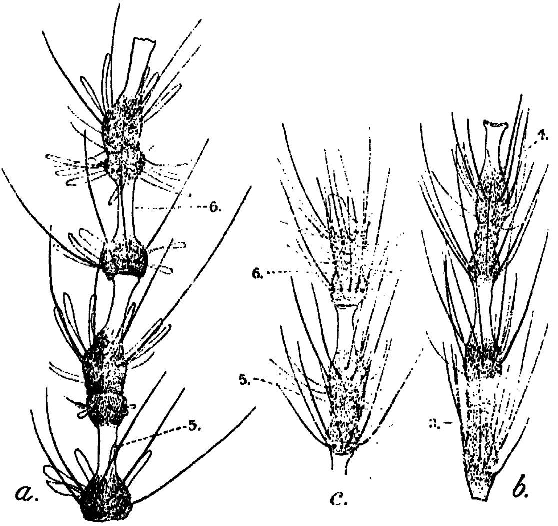
Palpi quadriarticulate. Antennal segments 14, binodose, stems unequal; circumfila well developed, regular, loops as long as or longer than enlargements. Claws simple on all legs, twice the length of pulvilli. Cross-vein present but not well developed. Ovipositor very long, sometimes longer than body. Dorsal plate of male genitalia short, triangular and heavily chitinised; basal clasp segment long and oval; terminal clasp segment short, triangular, curved and broad basally.

Genotype.—Xylodiplosis praecox (Winn.). (By original designation.)

Xylodiplosis kempi, sp. nov.

(Text-figs. 27 and 28.)

Male.— Badly mutilated. Body dark brown, densely hairy. Fourth antennal segment (?) with stems equal to and three-fourths the lengths of enlargements, basal enlargement globose, apical enlargement subcylindrical, with a length about twice its diameter and constricted in the middle; fifth antennal segment with stems one half greater than and equal to enlargements, apical enlargement constricted at its basal



TEXT-FIG. 27.—*Xylodiplosis kempi*, sp. nov. *a.* antennal segments of male; *b.c.* antennal segments of female.

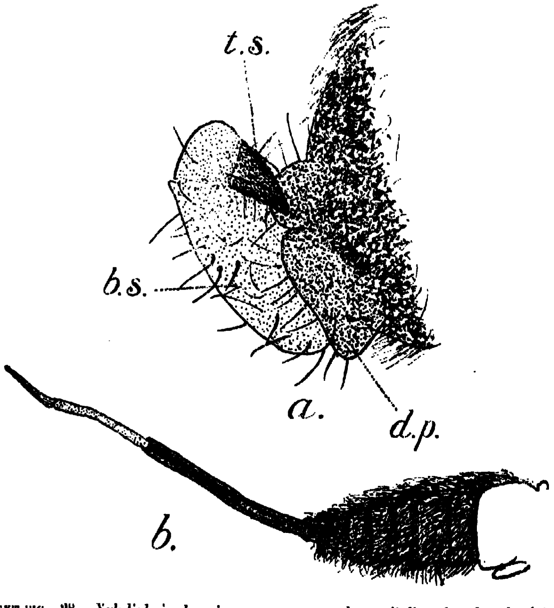
fourth. Genitalia yellowish-brown; basal clasp segment long, oval and setose; terminal clasp segment short, triangular, curved, broad

basally, somewhat chitinised and sparsely setose; dorsal plate short, triangular and heavily chitinised.

wemale.— 2 mm. long. Body reddish-brown, densely hairy. Terminal part of antennae broken. Third segment with a stem a little less than one-third the length of enlargement, which latter is thickened both basally and apically; fourth segment united with third, stem about half the length of enlargement, which latter has a basal globose thickening and an apical fusiform thickening, the constriction in the middle being narrower than that in the third segment; fifth segment a little shorter than fourth, with a stem three-fourths the length of enlargement, which latter has a globose basal and an obpyriform apical swelling. Mesonotum brown. Scutellum yellowish-brown. Abdomen dark reddish-brown. Pulvilli about half the length of claws. Ovipositor reddish in colour and longer than body.

Holotype.— Female, on slide. No. $\frac{1010}{H\ 6}$.

Allotype.— Male, badly mutilated and partly dissected, on the same slide as the holotype. No. $\frac{1011}{H\ 6}$.



TEXT-FIG. 28.—*Xylodiplosis kempi*, sp. nov. *a.* male genitalia; *d.p.* dorsal plate, *v.p.* ventral plate, *t.s.* terminal clasp segment, *b.s.* basal clasp segment; *b.* female genitalia showing the long ovipositor, part of which is still inside the abdomen.

Type-locality.— Castle Rock, North Kanara District, Bombay Presidency. Coll. S. Kemp, 11-26.x.1916.

Genus **Hormomyia** H. Loew.

1818. *Cecidomyia (partim)*, Meigen, *Syst. Beschr.*, I, p. 94.
1850. *Hormomyia*, Herman Loew, *Dipt. Beitr.*, IV, pp. 20, 31.
1861. *Anyrlinia*, Rondani, *Atti Soc. Ital. Sc. Milano.*, II, p. 290.
1908. *Hormomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 124, p. 387.
1911. *Hormomyia*, Felt, *Journ. N. Y. Entomol. Soc.*, XIX, p. 57.
1913. *Hormomyia*, Kieffer, *Gen. Ins.*, fas. 152, p. 137.
1920. *Hormomyia*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 271.
1921. *Hormomyia*, Felt, *Bull. N. Y. St. Mus.*, Nos. 231-232, p. 209.
1925. *Hormomyia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 170.
1928. *Hormomyia*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 6.

Prior to 1921 there was great confusion regarding the diagnosis and type of this genus. After an examination of all the available literature, Felt designated *Cecidomyia crassipes* Meig. as the type. He summarises the characters of this genus as follows :

Palpi tri-, bi-, or sometimes uniarticulate. Antennal segments 15-27 in male and 14 or more in female, flagellate segments of female strongly constricted. Wings generally long and narrow, third vein united with the costa at or beyond the apex. Mesonotum greatly produced over the head. Claws stout, long, evenly curved and generally simple. Pulvilli often reduced in male. Basal clasp segment stout. Terminal clasp segment obtuse and with a somewhat rudimentary spur. Dorsal plate broadly emarginate. Ventral plate short and broad. Terminal lobes of ovipositor broad.

Key to species.

I. Wings normal, *i.e.*, long and narrow and reaching to two-thirds the length of abdomen . . . . . *H. ischaemi* Felt.

II. Wings very short, *i.e.*, less than one-fourth the length of body . . . . *H. subaptera* Felt.

Hormomyia ischaemi Felt.

1920. *Hormomyia ischaemi*, Felt, *Pusa Bull.*, No. 89, p. 46.
1920. *Hormomyia ischaemi*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 271.
1928. *Hormomyia ischaemi*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 6.

This is a dark brown or dark reddish-brown species, which produces galls on *Ischaemum pilosum* Hack. Felt believes that *Oligotrophus ischaemi* Kieff. is probably identical with this species, which I am inclined to doubt.

Hormomyia subaptera Felt.

1926. *Hormomyia subaptera*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, IX, p. 224.

This is a smaller midge with relatively very short wings. Felt has only provisionally referred it to this genus.

Genus **Dyodiplosis** Rubs.

1899. *Hormomyia (partim)*, Rubsaamen, *Biol. Central-blatt.*, XIX, p. 602.
1912. *Dyodiplosis*, Rubsaamen, *Zeit. Wiss. Insektenbiol.*, VIII, p. 49.
1913. *Dyodiplosis*, Kieffer, *Gen. Ins.*, fas. 152, p. 205.
1920. *Dyodiplosis*, Brunetti, *Rec. Ind. Mus.*, XVII, pp. 14, 271.
1921. *Dyodiplosis*, Felt, *Bull. N. Y. St. Mus.*, Nos. 231-232, p. 208.
1925. *Dyodiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 170.
1928. *Dyodiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 12.

This genus is distinguished from *Hormomyia* H. Loew by the thorax being not much produced over the head to two moderately long circumfila on the flagellate antennal segments of female and by the truncate ventral plate. Third vein united with costa well beyond the apex of wing. Basal clasp segment unarmed, style not expanded apically and not strongly chitinised at the sides. Ovipositor short.

Seven Indian species, breeding in grasses, were described by Felt: *generosi* (58), *andropoginis*, *cornea*, *fluvialis* (63), *indica*, *monticola* and *plumosa* (72).

Genotype.—Dyodiplosis arenaria (Rubs.). (By original designation.)

Genus **Lowiola** Kieff.

1875. *Diplosis* (*partim*), Loew Franz, *Verh. zool.-bot. Ges. Wein.*, XXV, p. 20.
1896. *Lowiola*, Kieffer, *Miscell. Entomol.*, p. 5.
1913. *Lowiola*, Kieffer, *Gen. Ins.*, fas. 152, p. 206.
1920. *Lowiola*, Brunetti, *Rec. Ind. Mus.*, XVII, p. 15.
1925. *Lowiola*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 172.
1928. *Lowiola*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 13.

Palpi triarticulate. Antennal segments without any unusual processes, circumfila loops as long as or longer than enlargements. Third vein united with costa beyond the apex of wing. Basal clasp segment not distinctly lobed, dorsal plate deeply and narrowly incised, ventral plate narrowly emarginate. Ovipositor moderately long, lamellae deeply bilobed.

Felt (58) described one Indian species, *costata*, from Ceylon.

Genotype.—Lowiola centaurae (H. Loew.).

Genus **Orseolia** Kieff. & Mass.

1902. *Orseolia*, Kieffer & Massalongo, *Marcellia*, I, p. 56.
1913. *Orseolia*, Kieffer, *Gen. Ins.*, fas. 152, p. 151.
1925. *Orseolia*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 173.
1928. *Orseolia*, Senior-White, *Cat. Ind. Mus.*, pt. 15, p. 7.

This genus is related to *Orseoliella* Kieff. but differs in its biarticulate palpi. Stems of first flagellate antennal segment of male have a lateral tooth near its middle. Claws simple on all legs. Dorsal plate narrowly incised. Ventral plate longer and rounded apically.

The genotype, *cynodontis* Kieff. and Mass., has been recorded by Kieffer (111) from Ceylon and by Felt (72) from South India. It breeds in various species of *Cynodon*.

Genus **Horidiplosis** Felt.

1920. *Horidiplosis*, Felt, *Mem. Dept. Agric. Ind., Entomol. Ser.*, VII, p. 10.
1925. *Horidiplosis*, Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 175.
1928. *Horidiplosis*, Senior-White, *Cat. Ind. Ins.*, pt. 15, p. 7.

Palpi uniarticulate. Antennal segments 14 in both sexes, circumfila not doubled. Wings hyaline. Claws simple on all legs. Dorsal plate deepdly, broady and roundly emarginate. Ventral plate broadly emarginate. Ovipositor stout and with a length about two-thirds that of the abdomen.

The type, *H. fici* Felt, is a dark, reddish-brown or yellowish species, with long tapering palpus, and breeds in pustule-like galls on leaves of *Ficus infectoria* Linn.

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EXPLANATION OF PLATE VII.

FIG. 1.—*Schizomyia acaciae*, sp. nov. Tomentose galls on the leaflets of *Acacia leucophloea* Willd.

FIG. 2.—*Asphondylia morindae* Mani. Clustered variety of the solid galls on the inflorescence of *Morinda tinctoria* Roxb.

FIG. 3.—*Asphondylia utriculae*, sp. nov. Utricular galls on the ovary of *Dichrostachys cineria* W. & A.

FIG. 4.—*Cecidomyiella crataevae*, sp. nov. Fleshy galls on the leaflets of *Crataeva religiosa* Forst.

FIG. 5.—*Cecidomyiella crataevae*, sp. nov. Leaf bud galls.

Indian Midge Galls.

ON SOME SAWFLIES (HYMENOPTERA: TENTHREDINIDAE) FROM THE INDIAN MUSEUM, CALCUTTA.

By René Malaise, *Stockholm.*

I am very grateful to the authorities of the Zoological Survey of India, Indian Museum, Calcutta, for sending me, at my request, a very interesting collection of sawflies, mainly from the Himalayas, for study. Since writing up the report I had an opportunity of studying the types of sawflies, described by Cameron and Smith, preserved in the British Museum (Natural History), London, Hope Collection, Oxford, and the Indian Museum, Calcutta, and the changes in synonymies, etc., rendered necessary by this study are incorporated in the present report.

Tribe TENTHREDININI.

Genus **Pëus** Konow.

Pëus pannulosus Konow.

One ♀, from Darjeeling, alt. 7,000 ft., June-July, 1916; E. Brunetti.

Genus **Dipteromorpha** Kirby.

Dipteromorpha spinosa (Cameron).

Two ♀, from Pashok, Darjeeling District, alt. 4,500—5,000 ft., 26-v—14-vi-1916; F. H. Gravely.

My study of the type of *Tenthredo spinosa* Cameron has convinced me that it is identical with the species later described as *Dipteromorpha dentisterna* Rohwer; similarly *D. spinifera* Mocsary is the same as *Tenthredo fentoni* Kirby.

Genus **Metallopëus,** gen. nov.

The new genus *Metallopëus* belongs to the Tribe Tenthredinini, and is closely allied to the genera *Tenthredo* Linn. (=*Tenthredella* Rohwer) and *Pëus* Konow.

The nervation of the wings is identical with that of the genus *Tenthredo.* The antennae may be shorter than the thorax and longer than the abdomen, but always strongly taper towards the apex and are mostly somewhat compressed. The scutellum and the mesopleurae are always pyramidally raised, the latter generally bear a dorso-ventral carina, which runs to the apex of the pyramidal tubercle and is then continued to the meso-sternal thorns; these thorns are only rarely absent. Head behind the eyes in ♀ angulately enlarged, strongly carinate behind; supra-antennal tubercles strongly prominent; clypeus very big, truncate or nearly so at the apex, supra-clypeal furrow entirely absent. The first abdominal segment is divided in the middle by a

furrow which is wanting in the genus *Pëus.* The sub-apical tooth of the claws is always much longer and stouter than the apical. Head, thorax and abdomen always with a strong, bright metalic lustre.

Genotype.—Tenthredo clypeata Cam.

I refer to this genus *Tenthredo aericeps* Konow, *T. coccinoceros* Wood, *T. clypeata* Cam., *T. coerulea* Cam., *Pëus cupriceps* Konow, *P. splendidus* Konow and three undescribed species. The genus seems to be restricted to the higher ranges of the South-Asiatic mountains, at altitudes between 6,000—13,000 ft. The author has seen specimens of different species from Kashmir, Himalayas, Tibet, Assam, North Burma and Sze-Chuan (China); it has also been reported from Formosa.

Metallopëus clypeata (Cam.)

Two ♀, from Simla, W. Himalayas, alt. 6,000 ft., 6-viii-1918 and 9-ix-1918; E. Brunetti.

Genus **Tenthredo** Linn.

I consider the genus *Tenthredella* Rohwer to be a synonym of the Linnaean *Tenthredo.*

Tenthredo opacifrons, sp. nov.

Reddish yellow, upper surface of scape, pedicel and flagellum of antennae and hind tibiae and tarsi black; apex of middle tarsi and that of abdomen, chiefly above, blackish brown (the dark colour of the abdomen may be due to putrefaction). Wings, venation, costa and stigma reddish yellow, apex of both wings strongly infuscated, in the fore wings from a strongly marked straight line through the very apex of stigma.

Head distinctly narrowed and strongly carinated behind eyes. Post-ocellar area nearly quadrate, as long as wide, sloping from the raised middle carina to the rather deep, lateral furrow on either side. Antennal and inter-antennal furrows distinct, but not the post-ocellar and circum-ocellar. Middle fovae large but rather shallow, extending from between the antennae to middle ocellus and the feebly marked supra-antennal pit. Frontal area raised but not prominent. Supra-antennal tubercles absent; the margin of the antennal pit raised into a carina resulting in a rather narrow furrow between the antennae. Entire upper surface of head opaque; finely punctured, punctation denser on and around frontal area; orbits behind eyes and face below antennae smooth and strongly shining. Supra-clypeal furrow distinct; clypeus semi-circularly incised with obtusely rounded lateral teeth. Labrum almost rounded or somewhat pointed. Antennae slender, longer than abdomen, distinctly compressed; third and fourth joints sub-equal. Pronotal angles and mesonotum very minutely punctured; scutellum and its appendage with scattered punctures, former pyramidally raised to a rather sharp point. Mesopleurae strongly granulate, also pyramidally raised, with a strong but short carina at apex. Mesosternum shining, smooth with short, flattened thorns, hind metatarsus horter than all the succeeding tarsal joints. Claws cleft, sub-apical

tooth much longer and stronger than apical. Length 14 mm. ♀ unknown, but should be similar to the ♂.

2 ♂. from Pashok, Darjeeling District, alt. 4,000 ft., 26-v-16—14-vi-1916; F. H. Gravely.

Holotype No. $\frac{850}{H8}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta. *Paratype* in the author's Collection in Stockholm.

The new species is closely allied to *T. xanthoptera* Cam. and *T. lepcha* Cam., but in addition to other characters is easily separated from both the species by the punctured and not smooth frontal area.

Tenthredo xanthoptera Cam.

I have examined the type of *T. vitalisi* Turner and have no doubt about its being synonymous with *T. xanthoptera.*

T. xanthoptera is known from Dehra Dun District, U. P.; Shillong, Khasia Hills, Assam; Burma; Tonkin and Laos. In the collection before me there are 4 ♂, 5 ♀, collected from Kalimpong, Pashok and Gopaldhara, Darjeeling District.

Tenthredo lepcha Cam.

1 ♂, 2 ♀, from Pashok and Kalimpong, Darjeeling District.

Tenthredo lepcha var. **annandalei** Rohwer.

3 ♀, from Kalimpong and Gopaldhara, Darjeeling District.

T. annandalei was described as distinct species, but I have failed to find any differences between it and *T. lepcha.* It, however, has pale hind femorae, and brownish, not black, hind tibiae; I am, therefore, of opinion that it should be regarded as a colour variety of *T. lepcha.*

The condition in reference to var. *birmensis* Rohwer (*gribodoi* Konow *nec* Costa) is also similar. The punctation of the mesopleurae is somewhat stronger in the only specimen available—a co-type of *gribodoi* Konow kindly sent to me for comparison by Mr. Runar Forsius —but, as none of the specimens from Darjeeling have the punctation constant or exactly similar to that of *T. lepcha,* I consider this to be a variable character for the species.

The abovementioned species and varieties occur in the same place and in nature it would be almost impossible to distinguish them one from the other. When carefully examined with a microscope, they can be distinguished with the help of the following key :—

1. Mesosternum with distinct, flattened thorns; mesopleurae strongly, pyramidally raised.
   1. Sub-apical tooth of claws shorter than apical; upper surface of head shining, not punctured (Distribution: Mussooree, U. P.; Darjeeling District, Bengal; Sikkim; Assam; Burma; Laos, and Tonkin) . . . . . *T. xanthoptera* Cam. (*vitalisi* Turner).
   2. Sub-apical tooth of claws much longer than apical; upper surface of head dull, distinctly punctured (Distribution; Darjeeling District) T. *opacifrons*, sp. nov.

II. **Mesosternal thorns absent; mesopleurae smooth, shining, with only a few more or less distinct punctures, apex not strongly elevated, blunt; sub-apical tooth of claws longer and stouter than apical.**	
1. Limit of infuscated apex of fore-wing concave; a median, longitudinal, serrated, black band along entire length of abdomen except at apex (Distribution: Burma) . . .	*T. lepcha* Cam. var. *birmensis* Rohwer (*gribodoi* Konow).
2. Basal limit of infuscated spot of fore-wing straight; only upper and lower surface of apex of abdomen black.	
A. Hind legs with femorae, tibiae and tarsi quite black (Distribution; Darjeeling District, Sikkim)	*T. lepcha* Cam. (*typica*).
B. Hind femorae reddish yellow, tibiae more or less brown, tarsi black (Distribution: Nepal, Bhutan, Sikkim, Darjeeling District)	*T. lepcha* var. *annandalei* Rohwer.

Tenthredo spinigera Konow var. **hedini** Malaise.

3 ♂, 3 ♀, from Phagu, Kufri, Simla District; alt. 7,000—9,000 ft.; N. Annandale and B. Chopra.

The description of *hedini* as a variety of *T. spinigera* Konow was included in a paper which is being printed in *Arkiv för Zoologi*, Stockholm, but I am now inclined to consider it as a distinct species.

Tenthredo clavicornis Konow.

2 ♂, 1 ♀, from Pashok, Darjeeling District; alt. 2,500 ft.; F. H. Gravely.

Tenthredo cretata Konow.

2 ♂, 2 ♀, from Pashok, Darjeeling District; alt. 2,500 ft.; F. H. Gravely and E. Brunetti.

Tenthredo indica Cam.

1 ♀, from Simla; alt. 6,000 ft.; 1-viii-1918; E. Brunetti.

Tenthredo clepsydra, sp. nov.

Black with light yellow markings. Head black; the very wide inner and hind orbits upto middle of eyes; on the upper orbital area a nearly rectangular spot on either side of the post-ocular area, which is connected with the hind-orbits through a very fine yellow line running half way between the eye and the hind carina of the head, and basal part of antennae yellow; narrow apical margin of clypeus and an area in its middle, which is sometimes absent, blackish. Antennae black at base and apex; apex of 3rd, entire 4th, 5th and base of 6th joint yellow. Thorax black; major part of upper angles and a spot on the lower angle of pronotum, tegulae, angulate part of middle lobe of mesonotum, scutellum and its appendage but not the limit between them, postscutellum, upper half of mesopleurae and a large spot on the

sides of metusternum yellow. Abdomen black with a distinct bluish tinge; 1st segment, with the exception of a small black spot in the middle at the base, yellow, 2nd-6th tergites on either side with a big, rounded yellow spot, a similar spot in the middle of the corresponding sternites; the yellow spots of the tergites are separated from one another by hour-glass shaped black markings, which together appear as a double-toothed saw along the middle of the abdomen—the name of the species is in reference to the hourglass-shaped black marks of the tergites. Legs yellow, base of all coxae and femorae black, apex of tibiae and in the anterior pair of legs a line running from the apex of tibiae upwards yellow. Wings hyaline, fore-wings near apex somewhat infuscated, nervures and apex of stigma dark brown, base of stigma and costa brown.

Head quite smooth, strongly shining, strongly narrowed behind eyes and distinctly carinated in this region. Post-ocellar area less than ¼ as wide as long; lateral and post-ocellar furrows very sharp and rather deep, former as deep as antennal furrows. The antennal furrows with the post-ocellar furrow and a shallow one above the antennal tubercles form the boundaries of the nearly quadrate frontal area; from the frontal corners of the quadrate two fine but distinct furrows run to behind the middle ocellus and unite with one another—inside each of the furrows is a blunt ridge diverging downwards from the ocellus. Supra-antennal tubercles distinct, prominent at the base of antennae but less marked backwards and abruptly cut off behind by the furrow bounding the frontal area described above; between the tubercles is a deep furrow with a low, blunt median carina at its bottom. Supra-clypeal furrow shallow but distinct. Clypeus hardly convex, semi-circularly incised at apex, with rounded lateral teeth. Labrum nearly circular. Antennae longer than abdomen, hardly thickened before apex, distinctly compressed, 3rd joint slightly longer than 4th. Mesonotum extremely minutely and densely punctured, opaque. Anterior half of rounded scutellum smooth, shining; posterior half and appendages with few, scattered punctures. Middle of mesopleurae only slightly obtusely raised, densely but not strongly punctured; area round the elevation hardly punctured, with a distinct lustre. Mesosternum without thorns. Abdomen shining. Claws cleft; apical tooth a little longer than sub-apical. Length of ♀ 13-15 mm. ♂ unknown.

2 ♀, from round Pashok, Darjiling District; alt. 5,000 ft.; F. H. Gravely.

Holotype No. $\frac{851}{H8}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta; *Paratype* in the collection of the author.

This new species is closely allied to *T. indica* Cam. and *T. xanthopus* Cam., but differs in the sculpture of the head and colour; the colour of the abdomen of *T. clepsydra* is just the reverse of that of *T. xanthopus.*

Genus **Allantus** Panzer-Jurine.

Tenthredo Rohwer *nec* Linn. is, in my opinion, a synonym of *Allantus* Panzer-Jurine.

Allantus hymalayensis Radoszkovsky.

2 ♀, from the Simla Hills—Kufri to Phagu, alt. 8,000—9,000 ft., and Phagu alt. 9,000 ft., 18-v-1916; N. Annandale and S. W. Kemp. The first of the two specimens on which the following description is based, has been returned to the Indian Museum, Calcutta, while the second is retained for the author's collection. 1 ♀, from Kanasas, Chakrata, United Provinces; Forest Research Institute, Dehra Dun Coll. 1 ♀, from Killanmarg, Kashmir, alt. 10,500 ft., 15-vii-1931, T. B. Fletcher (Brit. Mus. Coll.).

From Smith's poor figure and description of *simillimus*, I was of opinion that his species is synonymous with Radoszkovsky's *hymalayensis* and this view was confirmed by examination of Smith's type. As I have not examined Radoszkovsky's type, but have identified the species from his description and very poor coloured sketch, I give below a description of my material. It may, however, be noted that my specimens agree with Smith's type of *simillimus* in all respects.

Head generally black. Clypeus and labrum black to reddish brown, former with two and latter with one large, light yellow spots at base. Mandibles with base lighter, middle region more reddish yellow. Antennae black, scape lighter in colour, pedicel and 3rd joint near the base more reddish yellow. Thorax generally black; upper and lower angles of pronotum light yellow; tegulae reddish yellow; scutellum quite black or usually with two, rarely confluent, light yellow spots; metasternum light yellow on both sides. Abdomen black with light yellow transverse bands; the bands are present on the first tergite and rather wide ones all round 4th and 5th segments, 3rd and 6th segments have a narrower hind margin, 7th - 9th tergites similarly have yellow hind margins and these together form a yellow spot near the tip of the abdomen. Legs reddish yellow; coxae, trochanters and larger part of femorae black, rest mainly on the under side reddish; sometimes the hind femorae are quite black, but in other specimens the reddish colour is more prominent; both the darker and light forms have the anterior edge of front femorae and tibiae more or less striped with light yellow. Wings yellowish, hyaline; radial and frontal half of cubital cells infumated dark brown, discoidal cell less strongly infumated; venation nearly black, costa and stigma reddish yellow.

Head distinctly enlarged behind eyes with a distinct carina behind, strongly and densely punctured or granulated. Post-ocellar area flat, nearly twice as wide as long, in front and on both sides distinctly marked off by rather fine and not too deep furrows; inter-ocellar furrow present. Pentagonal area hardly raised, rather indistinct; supra-antennal tubercules strongly raised with a deep, wide and flat-bottomed depression between them; tubercules about three times longer than wide. Supraclypeal furrow absent, area finely striated longitudinally. Malar space shorter than pedicel. Clypeus nearly flat, with a few scattered punctures, shining; at the apex deeply, rectangularly incised and with rather sharp, but rounded lateral teeth. Labrum pentagonal, with rounded angles. Antennae stout, little longer than thorax and distinctly thickened before apex; lengths of 3rd and 4th joints 7 : 4. Pronotum and mesonotum strongly and densely punctured, shining background

distinguishable between single punctures; mesopleurae granulated, posterior side of scutellum with dense and distinct and anterior side with confluent, shallow and indistinct punctulation; scutellum roundly raised, at the very apex with a shallow, longitudinal furrow; mesopleurae somewhat flattened, pyramidally raised, with truncate apex. First tergite of abdomen smooth, shining, following tergites comparatively strongly striated, quite dull. Apical teeth of claws longer than sub-apical. Length of ♀ 10·5—11·5 mm. ♂ unknown.

Allantus indica Kirby.

Black with yellow markings. Clypeus, base of mandibles, a minute spot at base of labrum in ♀, and entire labrum in ♂, upper angles and a spot near base of pronotum (but not the tegulae), yellow; there is also a large yellow spot on meta-sternum. Antennae black. Abdomen very differently coloured in ♂ and ♀. In ♀ the first six segments have yellow belts along the hind margins alternating with about as wide black rings, apex of abdomen above with a big yellow spot extending over the middle of last three tergites. Except for quite yellow genitalia, the underside of abdomen in ♂ has yellow transverse belts as in ♀, but hind margins of first and fourth tergites only are belted with yellow; 5th-8th tergites are yellow in the middle and have extremely narrow yellow marginal rings. Legs black; entire front side of first two pairs of legs in both sexes yellow, hind legs black; in ♀ apex of coxae, but in ♂ the front side of trochanters and of the basal portion of femorae also yellow. Wings, hyaline, fore-wings with a dark-brown infuscated shadow along the middle from the base to the apex, most prominent over the second cubital and both the radial cells, hind-wings only along the light-brown stigma less dark; nervures dark brown.

Head narrowed behind the eyes, coarsely punctured with large punctures, well separated by even and shining background. Front area and supra-antennal tubercules hardly raised, bordering antennal furrows very shallow; post-ocellar area sharply defined, 1½ times as wide as long, with the bordering lateral, posterior and inter-ocellar furrows sharp and rather deep; area as also entire head distinctly marginated behind; supra and inter-antennal furrows very shallow, bottom of the latter in the middle somewhat roundly raised. Clypeus large, evenly rounded, at the apex roundly emarginated. Malar space shorter than pedicel. Antennae shorter than thorax, from fourth joint strongly thickened before apex, 3rd joint twice as long as 4th. Meso-pleurae roundly bulging; mesosternum without thorns; almost smooth; scutellum nearly flat; rest of thorax with punctures as on head, but the punctures are fewer and towards the sides and front of mesonotum gradually disappear. Abdomen not visibly striated, strongly shining. Sub-apical teeth of claws distinctly larger, but only little longer than apical. Length 12-13 mm.

One ♀ labelled "Pashok, Darjeeling District, alt. 2,500 ft. 26-v—14-vi-1916, F. H. Gravely" from the collections in the Indian Museum, Calcutta. I have also examined one ♂ labelled "Sikkim, alt. 4,000 ft., April 1894, C. T. Bingham" in the British Museum collection.

This species apparently comes very near to *A. largifasciatus* Konow, from Sikkim, but according to Konow's description differs in the following points: The head is not narrowed behind the eyes; the post-ocellar area is as long as wide; the antennae are as long as the thorax and the first abdominal segment; the scutellum is raised as a cushion; length 15-16 mm. The sculpture of the head and thorax described as "capite et mesonoto crassius et sparsius, mesopleuris densius punttatis" is somewhat uncertain.

The statement of Enslin that *A. dudgeoni* Cam. is a synonym of *largifasciatus* Konow led the present author to describe the above species as new, but after studying Cameron's description and the types in the British Museum (Nat. Hist.), London, the supposed new species was found to be a synonym of *indica* Kirby. The types of *dudgeoni* Cam. were found to agree closely with *indica* Kirby, though the colouration of the ♂ and the ♀ is dissimilar.

Allantus salvazii, sp. nov.

Black above, dirty whitish yellow below and with a semi-circular light spot in the middle of 4th tergite. Antennae, head above the indistinct supra-clypeal furrow and on hind orbit to just below level of lower ocellus, the pronotum except the large upper and lower angles; meso- and metanotum and meso-sternum black. Mesopleurae light except for a black spot just under the wing; tegulae, frontal half of scutellum and two triangular spots on its appendage lighter. Abdomen black above, lighter below and on the sides. Wings hyaline, hardly darkened towards the apex, intercostal field distinctly light brown; costa, stigma and nervures dark brown, nearly black.

The ♂ is somewhat differently coloured. The infra-antennal area, the mesosternum and the frontal half of the meso-pleurae are lighter, but the scutellum and its appendage are quite black. The semi-circular light spot in the middle of the 4th tergite of the ♀ is, in the only available ♂, changed to an arrowhead-shaped spot over the 4th and 3rd tergites; in the middle of the 5th tergite there is also a faint indication of a light spot.

Head narrowed behind eyes, distinctly marginated behind; frontal area and its nearest surroundings finely and inside the area densely punctured, rest strongly shining. Post-ocellar area wider than long (4 : 3), in the middle with a distinct, shallow and longitudinal depression. Inter- and post-ocellar furrows equally sharp; lateral ones a little sharper and deeper. Frontal area distinctly raised, from the ocelli to the base of the antennae even, in the middle a little excavated. Malar space shorter than pedicel. Clypeus large, rounded and convex; at the apex the incision is roundly pentagonal with a flat bottom, lateral teeth obliquely truncate with rounded angles. Labrum as long as wide, rounded. Antennae of ♀ shorter than head and thorax, distinctly thickened before the apex; length of 3rd and 4th joints as 7 : 4; in the ♂ longer than abdomen, nearly filiform, length of 3rd and 4th joints as 4 : 3. Mesonotum densely and finely punctured, mesopleurae, if at all, with very minute, scattered punctures, shining, in the middle rounded to pyramidally raised; mesosternal thorns absent; scutellum a little

raised, rounded, frontal half hardly, the remainder densely and rather strongly punctured, punctures shallow, confluent. Abdomen strongly shining with very faint, hardly visible striation. Apical teeth of claws longer than sub-apical. Length 9-10 mm.

One ♂ and 3 ♀, the type, allotype and one paratype ♀ from Tonkin, Chapa, 20-v—1-vi-1916, R. V. de Salvaza; one paratype ♀ labelled "W. Himalayas, Simla, alt. 6,000—7,000 ft., jungle, viii—ix-1925, B. Chopra".

Type ♀, an *allotype* ♂ belong to the British Museum (Nat. Hist.), London; the Simla *paratype* belongs to the Indian Museum, Calcutta, Regd. No. $\frac{852}{H3}$; one *paratype* in the author's private collection.

I have associated this species with the name of the collector Mr. R. Vitalis de Salvaza.

Allantus felderi Radoszkovsky.

This is apparently a widely distributed and common species.

One ♂ and 4 ♀, all captured by N. Annandale and S. Kemp in the Simla Hills, Kufri to Phagu, alt. 8,000—9,000 ft., 18—21-v-1916.

A study of the types in the Indian Museum, Calcutta, has confirmed the author's view that *terminalis* Smith, *multicolor* Smith and *albipictus* Konow are all synonymous with *A. felderi* Radoszkovsky.

Allantus opposita (Smith).

One ♂, from "Round about Mussoorie, United Provinces"; 15-vi—1-vii-1930; B. Chopra. 3 ♀, from Simla, Western Himalayas; alt. 6,000 ft.; 26-vii—12-viii-1918; E. Brunetti.

These specimens have been compared with one ♀, received in exchange from the British Museum, belonging to the type-series of *Fethalia nigra* Cam. The first abdominal segment is divided along the middle and the "blotch" of Cameron is not, as he stated, absent. Cameron's *nigra* is a typical *Allantus* (*Tenthredo*) and is in no way related to the genera *Pĕus* Konow or *Jermakia* Jak., as Rohwer supposed (*Rec. Ind. Mus.* XI, 1915, p. 46). I have adopted the earlier specific name *opposita* Smith for the species, as after studying Smith's type in the Indian Museum, Calcutta, I found that Cameron's *nigra* does not differ from it in any characters.

I give below a key of the Indian species of the genus *Allantus* which I have studied.

I. Mesosternum with sharply pointed, somewhat flattened thorns; scutellum, viewed laterally, strongly raised and usually sharply pointed.

A. Scutellum viewed from behind quite truncate or obtusely rounded, sometimes a little pointed; head and thorax strongly punctured.

i. Scutellum, viewed laterally, rounded or obtusely pointed, frontal half usually quite white, sometimes black; ventral surface of head and body yellowish white; dorsal surface of abdomen distinctly bluish, under surface and 3rd tergite more or less white. Head

between eyes and post-ocellar area with big, dense punctures; hardly shining. Thorax finely but densely punctured. Wings clear, uniformly hyaline. (Distribution: At altitudes up to 11,000 ft. in Kashmir, Himalayas, Assam, Burma and South China) . *A. felderi* Radoszkovsky.

ii. Scutellum strongly flattened, in lateral view sharp, posteriorly quite truncate, somewhat emarginated at apex. Head with long black hairs; head and thorax strongly and densely punctured, supra-antennal tubercles distinct. 3rd tergite and whole body black, sometimes hind margins of 1st, 4th, 5th and 9th tergites yellow. Hind femorae and tibiae usually red, sometimes quite black. Frontal borders of wings, especially both radial cells, strongly infuscated. (Distribution: Kashmir) . . . . . *A. providus* Smith.

B. Scutellum, viewed from behind, very sharply pointed, its apex raised to a thorn-like tip.

i. Clypeus roundly emarginated, with a small tooth in the middle of the emargination; abdomen and rest of body black, without bluish tinge. Abdomen shining, tergites without distinct striations. Head and thorax finely but densely punctured, quite dull. (Distribution: Himalayas) . . *A. opposita* Smith.

ii. Clypeus roundly emarginated, without tooth in middle. Abdomen with a distinct bluish tinge; tergites striated. Smaller species. (Distribution: Sikkim and Tibet at alt. 12,000–16,000 ft.) . . . . . . *A. inguinalis* Konow.

II. Mesosternum without thorns; scutellum generally flat, or if raised, only rounded or obtuse, never sharply pointed.

A. Front margin of fore-wings distinctly infuscated, at least the radial cell; antennae short, distinctly thickened before apex.

B. Head greatly enlarged behind eyes, trapezoid in dorsal view; head and thorax strongly and densely punctured; supra-antennal tubercles raised; abdominal segments generally black with narrow, light yellow hind margins, 2nd segment always and sometimes 3rd quite black. Scape, pedicel, tegulae reddish yellow; two yellow spots on clypeus and one on pronotum, two small, confluent yellow spots on scutellum; metasternum light yellow. (Distribution: Kashmir, Western Himalayas to Chakrata, United Provinces) *A. hymalayensis* Radoszkovsky.

BB. Head narrowed behind eyes.

C. Head and thorax with large, well separated punctures; background between punctures even and shining; all abdominal segments polished and strongly shining (all those of the ♀ have the apical half yellow; the ♂ has only the apical third of the 1st and the 4th tergite yellow, the other tergites in the ♂ only very narrowly in the middle with an indication of a yellow margin). Mouth-parts, upper angles of pronotum and metasternum

yellow, body otherwise black. (Distribution : Tropical parts of Darjeeling District and Sikkim, alt. 2,500—4,000 feet, in the Eastern Himalayas) . . . . *A. indica* (Cameron).

CC. No smooth unpunctured spaces between punctures on head and thorax.

D. Supra-antennal tubercles strongly raised, about as high as long, strongly sloaping backwards; 3rd-6th abdominal segments quite red, other segments black. Hind femorae and tibiae red; head and thorax black, strongly and densely punctured; labrum and front side of the front legs white. ♀ unknown. (Distribution : Kashmir, Simla).

E. Corners of pronotum, the very apex of scutellum, a spot on meta-sternum and the hind margin of 1st abdominal tergite white . . *A. incognitus* Bingham (forma *typica*).

EE. No white on thorax or abdomen . . . *A. incognitus* Bingham var. *balobateus* Rhw.

DD. Supra-antennal tubercles not strongly raised; under-side of abdomen and hind femorae always black.

i. Head and thorax quite densely and rather finely punctured, every puncture distinct and deep, surface dull; 4th tergite above with very wide, reddish yellow hind margin; 1st tergite on each side with a minute light yellow spot and in the middle with reddish yellow narrow hind margin; 2nd and 3rd tergite quite black; the hind margins of the two or three last tergites and sometimes the sides of the 5th, the tegulae and hind pronotal angles reddish yellow; a yellow spot on mesosternum, in ♂ the mouthparts light yellow, in ♀ black, only the base of the mandibles reddish yellow. (Distribution : Assam) . *A. odyncrinus*, sp. nov.

ii. Head and most of mesonotum densely punctured, punctures confluent but not deep; with distinct, sometimes strong lustre; meso-pleurae and scutellum distinctly punctured; pronotal angles, tegulae and a spot in the middle of the 8th tergite always reddish yellow; colour of the mouthparts and of scutellum varying from black to yellow; at the base of the 3rd, 4th and 5th tergites a very narrow strip of yellow colour most prominent at the sides; rest of thorax and abdomen black. (Distribution : Assam, Himalayas) . . *A. trochanteratus* Cameron.

AA. Fore-wings not infuscated; head never enlarged behind eyes.

a. Malar space twice as long as pedicel; antennae except for 3rd joint light yellow, flagellum hardly enlarged before the apex; abdomen twice as long as thorax; scutellum strongly, pyramidally raised. Head and thorax rather densely and extremely minutely punctured; except for a narrow strip of mesopleurae the whole under-side

of the animal very light yellow. 3rd antennal joint; a big spot between the eyes; meso- and meta-notum with the exception of the scutellum, its appendage and post scutellum black. 3rd and 9th tergites quite light, all others with very big, nearly quadrate basal spots, leaving only the narrow, in the middle somewhat triangularly widened hind margins light yellow. (Distribution: Himalayas, Chakrata, U. P., alt. 7,000 feet). *A. beesoni*, sp. nov.

b. Malar space only as long as the pedicel; antennae black.

i. Entire head and thorax uniformly, strongly and densely punctured; under-side of animal except the mouth-parts and the metasternum, black; 1st, 3rd, 4th and 5th tergites with equally wide, light yellow hind margins; pronotal angles light yellow; frontal half of the scutellum and legs, except coxae and trochanters, yellowish red. (Distribution: Kashmir) . . . *A. kashmirica*, sp. nov.

ii. Mesopleurae and head, except round ocelli, nearly unpunctured, strongly shining; mesonotum and the pentagonal area minutely and rather densely punctured; upper part of mesopleurae, and in ♀ mesosternum, black; otherwise the whole under-side light yellow; above black, pro-notal angles, tegulae. frontal half of scutellum, sides of its appendage and a nearly semi-circular big spot in the middle of the 4th tergite light yellow. (The ♂ has the scutellum and its appendage quite black and the light spot in the middle of the abdomen above is triangular and extends from the 4th tergite over to the 3rd). Antennae of ♀ much shorter than abdomen, distinctly thickened before apex; in ♂ nearly filiform and longer than abdomen. (Distribution: Tonkin and Simla in the Himalayas) . *A. salvazii*, sp. nov.

Genus **Macrophya** Dahlbom.

Macrophya tenuicornis Rohwer.

3 ♂, 4 ♀, all from between Pashok and Kalimpong, Darjeeling District, alt. 600—4,500 ft., 24-iv—10-v-1915 and 2-v—14-vi-1916; F. H. Gravely.

Macrophya regia Forsius.

One ♀ of this brilliant species is labelled: " Kalimpong, Darjeeling district, E. Himalayas, 4.500 . 24-iv—10-v-1915, F. H. Gravely."

The origin of this species was hitherto most uncertain. The only known ♀ occurred in a collection with the label " probably from China, otherwise possibly from Sumatra ".

Genus **Pachyprotasis** Hartig.

Pachyprotasis maesta, sp. nov.

Black; two spots on clypeus, base of mandibles; supra-clypeal area; wide lower, hind and inner orbits up to half the eyes light yellow; from that point the inner orbits continue with a very narrow strip to the upper corner of the eye and grows from here a trifle wider continuing to the posterior corner of the post-ocellar area. Labrum reddish yellow, antennae quite black. Sides of pronotum and base of tegulae margined with yellow. A spot near front margin of mesopleurae, a strip along middle of scutellum and most of its appendage; entire postscutellum and in the paratype a very minute spot or point on each lateral corner of the middle of scutellum and most of its appendage; entire postscutellum and in the paratype a very minute spot or point on each lateral corner of the middle lobe of mesonotum; the upper part of metasternum and most of metapleurae light yellow. 2nd-7th abdominal segments all around with yellow hind marginal rings, dorsally very narrow, less so ventrally; dorsally only the 3rd-5th marginal rings complete. The base of saw-sheath and most of 9th tergite yellow. Legs reddish; all coxae black, their apices and trochanters yellow. Apices of all femorae and four frontal tibiae and tarsi striped with black behind. Hind legs more prominent reddish brown, very apex of hind tibiae and a line on hind tarsae black. Wings nearly quite clear, nervation, costa and stigma brownish black.

Head behind eyes narrowed and margined with rather big, scattered punctures, strongly shining between the punctures. Post-ocellar furrow absent; the area, therefore, seems longer, measured from the ocelli is $1\frac{1}{2}$ times wider than long. Lateral furrows hardly depressed, only marked as very fine, hardly visible, curved and forwardly converging lines. Frontal area missing, supra-antennal pit round and rather sharp. Clypeus convex, with a few large but shallow and indistinct punctures, at the apex rectangularly incised. Labrum truncate. Antennae longer than the abdomen, flagellum tapering slightly from the middle; 3rd joint a trifle longer than 4th. Mesonotum evenly, but not densely punctured; punctures and shining areas between them distinct; mesopleurae strongly and rather densely punctured with opaque lustre. Punctures on scutellum less distinct than on mesonotum. Tergites in the middle not or hardly emarginated, strongly shining. Saw-sheath normal for the genus. Hind basi-tarsus a trifle longer than all the following joints. Claws cleft, both teeth equally long, but sub-apical a little stouter. Length 7-8 mm. ♂ unknown.

2 ♀, both from Darjeeling, alt. *ca.* 7,000 ft., the *type* in the Indian Museum; Regd. No. $\frac{858}{H8}$, 6-v-1917 and the *paratype*, 23-v-1917; E. Brunetti, in the author's collection.

In my key (*Entom. Tidskrift, Stockholm* 1931, p. 133) this species comes near *P. versicolor* Cam. or *P. variegata* Fall., but does not agree

with either of them. It differs from *versicolor* in having a smooth unpunctured head. In *variegata* the punctation on the mesopleurae is much more obliterated and confluent and there is a distinct lustre, but the head, owing to a minute punctuation between the bigger and also confluent punctures, is not so strongly, if at all, shining. Both species are also differently coloured.

Pachyprotasis versicolor Cam.

This species differs from all the known species of the genus *Pachyprotasis* in the highly raised supra-antennal tubercules which produce a deep and in cross-section triangular furrow between the antennae. These latter also are much longer than those of any known species of the genus, being longer in both sexes than the whole body.

11 ♂, 3 ♀, all from Darjeeling, alt. *ca.* 7,000 ft., 23-29-v-1917, E. Brunetti; one ♂ labelled "Pashok, Darjeeling distr., alt. 4,000 ft., 26-v-1914, F. H. Gravely".

A single ♂ and a ♀ both from Darjeeling collected by E. Brunetti apparently represent two new species, but the author does not think it advisable to describe new species based on single specimens in such a variable genus as *Pachyprotasis*.

Genus **Siobla** Cameron.

Siobla punctata Cameron.

7 ♂, all labelled "Darjeeling, alt. *ca.* 7,000 ft., vi—vii-1916; E. Brunetti".

Genus **Laurentia** A. Costa.

Laurentia punjabica, sp. nov.

Black; labrum, very narrow inner margins of eyes, an elongated spot on upper hind orbits, narrow margin of pronotum, tegulae and posterior half of meta-epimerae white; 4th-6th abdominal segments red above and below; legs reddish; all coxae and most of four front trochanters black, hind trochanters more or less light yellow; apex of hind tibiae and apical ⅘ or tarsi infuscated to black; antennae black; wings hyaline, venation, costa and stigma blackish brown.

Hind wings of ♀ with only one closed middle cell—the cubital; ♂ with two; lanceolate cell petiolate. Clypeus rounded or angularly but not deeply emarginate. Labrum short, rounded or obtusely pointed. Inner margins of eyes straight, not emarginate, distinctly converging towards mouth. Malar space hardly longer than diameter of an ocellus. Supra-antennal tubercles absent. Hind margin of head below and along orbits rounded, not carinated, above with a distinct, though not strong, angulate carina. Antennae as long as abdomen, stoutly filiform, neither compressed nor tapering towards apex; scape and pedicel roundly conical; both little longer than apical width; pedicel shorter than scape. Neither scutellum nor mesopleurae pyramidally raised. 1st abdominal tergite divided along the middle. Hind coxae not

elongated, femorae not reaching the apex of abdomen. Hind basitarsus shorter than all succeeding tarsal joints together. Claws without basal lobe, apex cleft; sub-apical tooth stronger and normally longer than apical.

Head enlarged behind eyes, then strongly narrowed; surface covered with fine, irregular wrinkles, not quite opaque, but lustre not strongly marked. Post-ocellar area $2\frac{1}{2}$ times wider than long; lateral furrows very deep, parallel; post-and inter-ocellar furrows equally fine, rather deep; antennal furrows shallow. Frontal area hardly raised, but distinct. Supra-antennal pit large, shallow, more or less distinctly continued as wide but shallow middle fovea to central ocellus; no longitudinal furrow between base of antennae. Clypeus large, with right-angled teeth; supra-clypeal furrow deep but not sharp. 3rd antennal joint $\frac{1}{6}$—$\frac{1}{3}$ longer than 4th. Thorax nearly smooth, strongly shining with almost indistinct fine puncture; limit between scutellum and its appendage marked by large punctures; two or three indistinct puncture on middle of scutellum; rest of scutellum, its appendage and post-scutellum quite polished, strongly shining. Abdominal tergites smooth, not striated. Length of ♀ 7-8 mm.

Holotype ♀ from Dal above Dharmsala, Punjab, alt. 5,500 ft., 31-v-1926; S. L. Hora, in the Indian Museum, Calcutta, Registered No. $\frac{853}{H3}$. *Paratype* labelled Phagu-Kufri, Simla Hills; alt. 9,000—8,000 ft., N. Annandale and S. Kemp; in the author's collection.

In the females of the genus *Laurentia* A. Costa, there are in the hind-wings generally two closed middle cells, as in the males, but the character is not apparently quite stable and I am, therefore, not separating *L. punjabica*, sp. nov. with a single closed middle cell in the hind-wing of ♀ into a distinct genus. The new species described above also differs in the malar space being hardly longer than the diameter of an ocellus whereas in other species it is twice as long; the clypeus is also not truncate but rounded or angularly but not deeply emarginate.

I have also examined an unidentified ♂ in the collection of the Indian Museum, Calcutta, from the Yarkand collection.

Tribe SELANDRIINI.

Genus **Darjilingia,** nov.

Belongs to the tribe Selandriini and is related to the genera *Taxonus* Htg., *Parasiobla* Ashm. and *Ametastegia* A. Costa.

Fore-wings with 2 radial and 4 cubital cells, 2nd and 3rd about equal in length or 3rd a little longer; each with a recurrent vein; basal vein joins sub-costa shortly before the origin of cubitus and runs parallel to the first recurrent vein; nervellus reaches discoidal cell about basad of the middle; lanceolate cell with an oblique cross-vein joining the brachium at an angle of about 60°. Hind-wings without closed middle cells and without surrounding nervures; lanceolate cell not petiolate. Body elongated. Head a little wider than thorax, with protuding eyes and strongly narrowed behind them. Inner margins of eyes nearly parallel. Malar space distinct, hardly shorter than the diameter of an

ocellus. Clypeus slightly convex, very widely and deeply emarginated, with the lateral teeth usually sharp and protuding; labrum big and flat, obtusely angulated at apex. Antennae nearly as long as the whole body, scape twice as long as wide, oval somewhat wider than pedicel; pedicel roundly triangular, hardly wider than long; flagellum equally thick, but distinctly compressed; 3rd joint as long as or ¼ shorter than 4th, in ♂ equal to 5th; in ♀ longer. Antennal organs absent. The mesopleurae without presternae. Hind basi-tarsus as long as all the succeeding tarsal joints; all of them are slightly, but distinctly compressed. Claws with big, flattened basal lobe and a sub-apical tooth, which is much longer than apical.

Genotype.—Darjilingia gribodoi (Konow).

Darjilingia gribodoi (Konow).

One ♂ captured at Darjeeling, Eastern Himalayas, alt. *ca.* 7,000 ft., 6-vi-1917; E. Brunetti.

Taxonus gribodoi was supposed to be from Borneo, but a large number of sawflies supposed to have been captured in Borneo by Gribodoi have later proved to have come from Burma.

A redescription of the species based on the specimen from Darjiling is given below.

Black; clypeus, labrum, supra-clypeal triangle, last three antennal joints, margin of pro-notum, a spot on scutellum, upper fourth and an oval spot near the hind margin of mesopleurae, meta-pleurae and four apical joints of the hind tarsi yellowish white; three basal joints of antennae, tegulae, legs and most of abdomen reddish yellow to light reddish brown; base of coxae, two basal abdominal segments and hind metatarsi black; abdominal segments above with indications of dark-brown bands; wings clear, apical half hyaline; venation, costa and stigma dark brown.

Head, thorax and abdomen smooth and strongly shining; hind orbits margined below and behind, but not above. Post-ocellar area convex, in ♂ nearly twice as wide as long, in ♀ quadrate or slightly longer than wide (in type of *T. pulchripes* Cam.), with deep sub-parallel or slightly curved lateral furrows that do not reach hind margin; post-ocellar furrow distinct and angulated. Frontal area indistinct. Supra-antennal pit big and deep, continued upwards to the middle ocellus as a shallow, but distinct middle fovea. Antennal furrows shallow, but distinct and complete; supra-clypeal furrow sharp and deep. Scutellum slightly convex. Length 6 mm.

Since the preparation of the above manuscript I have examined the type of *Taxonus pulchripes* Cam. 1899, and find that it is a synonym of *gribodoi* Konow. The type of *pulchripes* is labelled "Khasia Hills, Assam".

Genus **Indostegia**, nov.

The genus *Indostegia* belongs to the tribe Selandriini and is closely allied to *Parasiobla* Ashm., *Ametastegia* A. Costa, *Indotaxonus* Malaise and the above described new genus *Darjilingia*.

The venation of the wings is as in *Darjilingia*, but the cross-vein of the lanceolate cell is more oblique, joining the brachium at an angle of 35-40°. Except for the post-ocellar area the head has a distinct hind margin and frontal area. Hind orbits as wide as maximal width or facette eye. Inner margins of eyes parallel, malar space is long, 1½ times as long as the diameter of an ocellus. Clypeus slightly convex, at the apex very widely and deeply incised, with sharp, somewhat depressed lateral teeth as in *Taxonus agrorum* Fall. Labrum large, flat, and shining. Antennae as long as the entire animal; flagellum, except for the three basal joints, very strongly flattened and tapering towards apex; scape 1½ times longer than wide, oval, with truncate apex, 1½ times wider than the pedicel; pedicel as long as wide at apex. Mesopleural episternae without presternae. Hind basi-tarsi hardly flattened, as long as all succeeding joints. Claws nearly cleft, subapical tooth a trifle shorter than apical; basal lobe very minute, but distinct (as in the genus *Parasiobla* Ashm.).

Genotype.—Indostegia apicicornis, gen. *et* sp. nov.

Indostegia apicicornis, sp. nov.

Reddish brown; labrum, 7th and 8th antennal joints, margin of pro-notum, all trochanters with apex of coxae and utmost base of femorae and hind tarsi yellowish white. A spot covering frontal area, 4th-6th and 9th antennal joints, centre of the meso-notal middle-lobe, metathorax, including appendage of scutellum, postscutellum and base of all coxae black; inside of femorae, especially the hind ones, first abdominal segment and the sawsheath blackish. The ground colour of the abdomen is light reddish yellow, but this colour is covered with very dark brown spots and bands so that it is only visible as fine lines between the segments, on the sides of 2nd to 5th tergites and in the middle of the basal sternites. Wings hyaline; venation dark brown; costa and stigma brown, sub-costa between stigma and connecting point to the base of the cubital vein yellowish white.

Head and mesonotum smooth and shining. Maximum width of the head over and behind eyes equal. Post-ocellar area convexly raised, as long as wide, lateral furrows deep, hardly curved and nearly parallel. Post-ocellar furrow distinct, angulated, at the very angle interrupted by a minute middle-carine, which does not reach the middle of the area. Antennal furrows complete. Frontal area distinct, below surrounded by a blunt wall, that extends down between the antennae and encloses the rather large supra-antennal pit. Supra-clypeal furrow deep; clypeus densely punctured, opaque. 3rd, 4th and 5th antennal joints about equal and 9th longer than 8th. Scutellum nearly flat, the limit between it and the appendage marked with big punctures, the appendage and at least the hind part of scutellum with very shallow and feeble, wrinkled punctures. Lateral parts of pronotum finely wrinkled, but mesopleurae very coarsely, rather reticulately punctured. Meso-sternum and the abdominal segments quite smooth and strongly shining. Length 9 mm.

One ♀, holotype from Darjeeling, Himalayas, alt. 7,000 ft.; 2-vi-1917; E. Brunetti.

Holotype in the collection of the Zoological Survey of India (Indian Museum), Calcutta; Regd. No. $\frac{854}{H3}$.

Genus **Stromboceros** Konow, *s. lat.*

Stromboceros sikkimensis, sp. nov.

Black with a bluish tinge; utmost apex of femorae and front side of tibiae of four front legs, apical third of coxae, and more or less the trochanters of hind legs in ♀ the basal $\frac{3}{4}$ of tibiae and of tarsi, in ♂ only basal half of tibiae white. Wings clear, against the apex somewhat hyaline, nervation, costa and stigma brownish black. First abdominal segment in ♀ with distinct, the following segments in both sexes with indistinct white margins and in ♀ the 7-9 tergites in the middle with big triangular, whitish membranous blotches.

Head and thorax quite smooth and strongly shining. Head strongly narrowed behind eyes, lower half strongly carinated, the upwardly diminishing carina obliterated above middle of eyes. Hardly convex post-ocellar area narrowing forwards, behind as wide as long, post-ocellar furrow absent, but lateral ones fine and rather deep, strongly curved forwards, behind not reaching nearly angularly broken hind margin. Circum-ocellar furrow distinct, inter-ocellar much shallower. In ♀ pentagonal area flat and distinct, but hardly so in ♂. Supra-antennal pit large and round, from above nearly surrounding a minute tubercule. Antennal furrows nearly obsolete, but on each side and a little above supra-antennal pit each furrow deepens into a round pit, as large as the supra-antennal. Supra-clypeal area small, nearly quadrate, furrow fine, but distinct. Clypeus in the middle with an angularly raised, transverse ridge, at the apex depressed and very shallowly, somewhat angularly, emarginated, nearly truncate. Labrum is small and roundly angulated. Malar space short, but distinct, about as long as half the diameter of an ocellus. Inner margins of eyes nearly parallel, hind orbits not specially wide. Antennae longer than thorax and head together, but shorter than abdomen, flagellum from middle strongly tapering towards apex, in both sexes with antennal organs. 3rd and 4th joints sub-equal, pedicel sub-conical, distinctly longer than its apical width; scape more rounded, larger than the pedicel and about twice as wide. Antennae with very short, black pile, but especially in ♂ there is at the very apex of the flagellar joints a pointed, minute brush of longer hairs which make the flagellum look somewhat serrate. Thorax and abdomen with scutellum and mesopleurae normal. Saw-sheath seen from above sharp-pointed, triangular, apical angle of about 40°. Hind basi-tarsus distinctly longer than all the succeeding joints. Claws without basal lobe, at the apex cleft, with the hardly shorter sub-apical tooth behind the apical. Length of ♀ 8·5 mm., ♂ 7 mm.

One ♀ *Holotype*, from Singhik, Sikkim, alt. 5,000 ft.; Maj. R. W. G. Hingston; in the collection of the British Museum (Nat. Hist.), London.

2 ♂, both from Darjeeling, E. Himalayas, alt. *ca.* 7,000 ft., 6-vi-17; E. Brunetti.

The ♂ *allotype* returned to the Zoological Survey of India (Indian Museum), Calcutta, Regd. No. $\frac{855}{H3}$; the *paratype* in the author's collection.

This new species is very like *Neostromboceros* Rhw. (*Stypoza* Enderl.), but the claws of that genus have a large basal lobe and the sub-apical tooth is stronger and usually longer than the apical one. In this and other respects this new species comes near to *Strombocerídea jacobsoni* Fors. and to some South-American *Stromboceros* Knw., *s. lat.* The author hopes to be able to undertake a revision of the genus *Stromboceros* in the near future, and it is likely that *S. jacobsoni* Fors. and the above described species will, as a result, have to be separated in a distinct genus if characters can be found to distinguish them from some of the South American forms.

Genus **Malachiella**, nov. [1]

The genus *Malachiella* belongs to the tribe Selandriini. The nervation of the wings is very like that of *Heptapotamius* Mal.[2], but the cross-vein of the lanceolate cell is much more oblique and the 3rd cubital cell, at least along the cubitus, is as long as the 2nd. The nervellus is just basad of the middle of the discoidal cell. The eyes are very prominent and the head, which is rounded, therefore, becomes narrower behind the eyes; the hind margin of the head is not visible. Between the very deep and wide, straight and parallel lateral furrows the post-ocellar area is strongly convex and wider than long. Antennal furrows are wide and shallow. The frontal crest is missing. The inner margins of the eyes are strongly convergent. The malar space is distinct and not quite as long as the diameter of an ocellus. The clypeus is rather long, only $\frac{1}{4}$ wider than long; in the middle deep, semi-circularly incised with two prominent, rather sharp teeth. The labrum is flat. The antennae are stout, hardly longer than head and thorax together, distinctly compressed, hardly widened at all before the apex. The scape is twice as long as wide; wider than the pedicel; this latter one a little longer than wide, the 3rd joint also a little longer than the 4th. No presternae are distinguishable. The hind basi-tarsus is as long as all the succeeding joints. The claws are divided, the sub-apical tooth being much shorter than the apical; the basal lobe is distinguishable only after dissection.

Genotype.—Malachiella rufithorax, gen. *et* sp. nov.

Malachiella rufithorax, sp. nov.

Black; pro- and meso-notum, tegulae, scutellum and upper part of mesopleurae dark red. Trochanters, especially the hind ones, dirty white. All knees and the front-side of the anterior tibiae light brown, remainder of the legs more or less dark brown to black. Basal half of wings clear, apical half hyaline or light infuscated; veins, stigma and costa brownish black.

Minutely punctured, shining. Post-ocellar area, if taken to the abrupt end of the lateral furrows, twice as wide as long, otherwise quadrate. Post-ocellar furrow hardly visible, inter-ocellar deep, sharp.

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[1] Named in honour of Herr N. Mallach, Berlin.

[2] The description of *Heptapotamius* Mal. is being published in the *Entom. Tidskrift, Stockholm.*

Pentagonal area raised, but not very distinct. From the lower ocellus extends downwards a shallow furrow ending in the punctiform supra-antennal pit, bordered on both sides by obtuse ridges reaching from this pit nearly to the lower ocellus. Supra-clypeal furrow distinct. Thorax normal. Scutellum rather flat. Sawsheath rather long, seen from above narrow. Length ♀ 7—7·5 mm., ♂ unknown.

4 ♀, from Himalayas and Assam; the type from Darjeeling, alt. 7,000 ft.; 10-vi-17, E. Brunetti; the paratypes from Simla, alt. 6,000—7,000 ft., jungle, VIII-IX-25, B. Chopra; Shillong, Assam; vi-1903; R. Turner.

The *type* belongs to the Indian Museum, Calcutta, Regd. No. $\frac{856}{H3}$, the *paratypes* are in the British Museum (Nat. Hist.), London, and in the private collection of the author.

Tribe BLENNOCHAMPINI.

Genus **Tomostethus** Konow.

I consider *Eutomostethus* Ensl. to be a sub-genus of *Tomostethus* Konow.

Tomostethus (Eutomostethus) assamensis Rohwer.

13 ♂, 13 ♀, all from Darjeeling, alt. 7,000 ft., 26-v—8-vi-1917; E. Brunetti.

Tribe ARGINI.

Genus **Cibdela** Konow.

Cibdela janthina Klug.

One ♂, 3 ♀ labelled "Above Tura, Garo Hills, Assam, alt. 3,500—3,900 ft., 15-vii—30-viii-1917; S. Kemp".

Genus **Pampsilota** Konow.

Pamsilota sinensis Kby., forma **typica.**

2 ♂, 1 ♀. Both ♂ were taken together with the colour-form *nigriceps* Rhw. "Above Tura, Garo Hills, at. 3,500—3,900 ft., 15-vii—30-viii-1917; S. Kemp"; the ♀ is labelled "Marianbari, Tea Estate near Pankhabari, alt. *ca.* 5,000 ft., E. Himalayas, 25-ii-1928; Gopi Ram".

Pamsilota sinensis Kby. var. **nigriceps** Rhw.

3 ♂, 2 ♀. Both ♀ and one ♂ labelled "Above Tura, Garo Hills, alt. 3,500—3,900 ft.; 15-vii—30-viii-1917; S. Kemp"; one ♂; "Kalimpong, Darjeeling distr., alt. 4,500 ft., 24-iv—10-v-1915; F. H. Gravely"; one ♂: "Balasan Forest, alt. *ca*, 400—500 ft., E. Himalayas; 3-iii-28; Gopi Ram".

In addition to the above material I have before me specimens from Sikkim, Tonkin, China and Java. I have also studied the types in the British Museum, London (except that of *microcephala* Voll.). All those from Java, 2 ♂ and 3 ♀ which were reared from cocoons, but from

different places, resemble each other in sculpture, but not in colour, size or nervation, and are easily distinguished from all the continental specimens. As *P. microcephala* Voll. was described from Java, I consider the Javanese insects to belong to that species. The ♀ from China has the clypeus at the apex nearly truncate, and the 3rd cubital cross-vein distinctly S-formed, so that the 3rd cubital cell is nearly ⅓ longer on the radius than on the cubitus. Usually the difference is much less and the cross-vein is curved in a simple arc. The two ♂ from the Garo Hills were probably taken at the same time, but one of them has the 2nd cubital cell longer than the 3rd and the cross-vein interstitial, but the other has the 3rd longer and the veins not interstitial. Exactly the same condition is to be seen in the two ♀ from Java, that emerged on the same date and also in two reared ♂ from another lot, from the same island. The cross-veins cannot, therefore, be considered as a reliable distinguishing character in this genus, certainly not more than the colour and the size.

The three Asiatic species may be distinguished as follows :—

I. Supra-clypeal area roundly raised, distinctly flattened in middle, the flattened space of a pentagonal form and nearly opaque. Saw-sheath seen from above not shorter than basal width. (Distribution: Java) . . . . *P. microcephala* Vollenhoven.

- *a.* Head, mesosternum, scutellum, metathorax, back of abdomen and saw-sheath bluish black, other parts of thorax red, and of abdomen reddish yellow . . . . . forma *typica.*
- *b.* ♀ Thorax red, only the very tip of scutellum and the boundary line between mesopleurae and mesosternum infuscated; abdomen as in forma *typica* . . . . var. *rufinus*, nov.
- *c.* ♂ Bluish black, only in under half of notum and upper apex of mesopleurae with reddish colour breaking through . . . . . var. *melanis*, nov.

II. Supra-clypeal area evenly, roundly raised, not flattened in middle; smooth, shining. Head, mesosternum and major part of legs black.

- *A.* Saw-sheath of ♀ elongated, each half seen from above nearly twice as long as basal width; thorax red, only mesosternum black.
  - i. Abdomen reddish yellow, without any black colouring. (Distribution: Assam, China) . . . . . *P. sinensis* Kirby. (forma *typica*).
  - ii. Abdomen black above, otherwise as in forma *typica*. (Distribution: Himalayas, Assam, Burma; China) . . *P. sinensis* var. *nigriceps* Rohwer.
- *B.* Saw-sheath short; each half, when seen from above, as long as basal line. Post-ocellar furrow distinct. Base of abdomen above and most of scutellum black.
  - i. Mesonotum and mesopleurae red; abdomen reddish yellow, tergites almost all black above. (Distribution: China) . *P. interstitialis* Cameron. (forma *typica*).
  - ii. Thorax quite black; only basal abdominal tergites black. (Distribution: Tonkin) . . . . *P. interstitialis* var. *euterpe* Turner.

Genus **Arge** Schrenck.

Arge praesternalis, sp. nov.

Metallic deep blue; thorax red, metathorax, scutellum, mesosternum and the under third of mesopleurae bluish. Antennae and palps black. Fore-wings strongly, hind-wings less infuscated, with a violet tinge. Nervation, costa and stigma black. Legs metallic deep-blue.

Head behind the eyes strongly widened, then rounded, not marginated. Post-ocellar area nearly twice as wide as long, lateral furrows hardly visible, post-ocellar furrow distinct, area raised a little, but not reaching the level of ocelli. Inter- and circum-ocellar furrows very fine, but distinct. Supra-antennal pit semi-circular, large. Just below the middle ocellus is another equally large and round, but very much shallower pit. High and sharp inter-antennal ridges are most elevated between the antennae and are nearly parallel, only converging very little from that point upwards and downwards; upwards they hardly reach beyond the supra-antennal pit, but do not meet below and extend to $\frac{1}{3}$ of the distance from the base of the antennae to the bottom of the clypeal emargination. Under-face roundly raised but not carinated, clypeus with minute, scattered punctures. The missing supra-clypeal furrow marked with very minute, longitudinal wrinkles. Apex of clypeus comparatively deeply, roundly incised. Antennae hardly longer than thorax; scape conical; pedicel sub-cylindrical, a little shorter than scape, apical half of the flagellum strongly flattened, $\frac{1}{3}$ before the apex at least twice as high as thick. Thorax and abdomen quite smooth and strongly shining. Mesopleurae along pro-notum from parapterum down, with a furrow separating off a narrow, but distinct prae-sternum, which becomes a little wider downwards. Saw-sheath, seen from above, rounded, shell-like. Length 13 mm.

One ♀, from Tura, Garo Hills, Assam, alt. 1,200—1,500 ft., 15-vi—15-vii-1917; S. Kemp. *Type* in the Indian Museum; Regd. No. $\frac{857}{H3}$.

Superfamily SIRICIDAE.

Genus **Paururus** Konow.

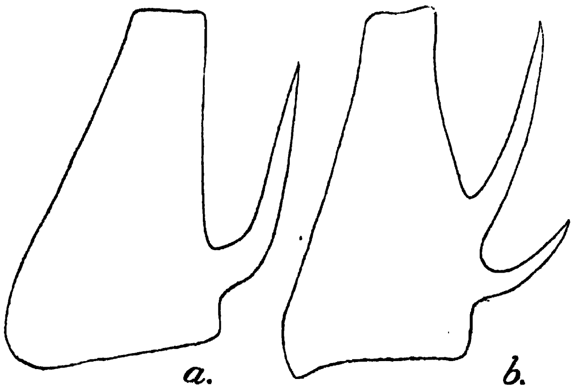
Paururus juvencus (Linn.).

2 ♂ labelled "Kohala, alt. 2,000 ft., Murree Sub-divn., Punjab, Sta. 34, 30-ix-1928; H. S. Pruthi".

ON A NEW SUB-SPECIES OF *PHRYNICHOSARAX COCHINENSIS* GRAVELY (PEDIPALPI: TARANTULIDAE).

By K. BHASKARAN NAIR, *B.A., Department of Zoology, Science College, Trivandrum.*

Phrynichosarax cochinensis was recorded by Gravely in 1915, from the jungles on the lower slopes of the Western Ghats in Cochin and also from the hills near Trichur. All the localities from which the species was then collected are situated in one comparatively small area, but even in this area slight variations were noticed. In August, 1933 I collected two specimens belonging to this species from Kallar, 30 miles to the east of Trivandrum and about 2,000 ft. above sea level. Later I was able to get many more specimens from the same locality and also from the Mookunni Hill (842 ft.) near Trivandrum. They were found in damp places adhering to the under surface of stones and fallen timber. All these specimens showed a marked variation from the typical form. They possessed two conspicuous spines along the dorsal margin of the finger of the arm. I have since examined a large number of specimens and found that this character is constant. Of the two spines the distal



Fingers of *Phrynichosarax cochinensis* Gravely and *P. cochinensis* var. *bispinosus*, nov.

a. Phrynichosarax cochinensis Gravely (after Gravely).

b. Phrynichosarax cochinensis var. *bispinosus*, nov.

one is longer, about twice as long as the proximal one. The larger spine is bent slightly parallel to the length of the finger. On account of this difference between my specimens and the type, the former may, as was kindly suggested to me by Dr. F. H. Gravely in a letter, be regarded as belonging to a local race for which I propose the sub-specific name *bispinosus*, nov.

REFERENCES.

1915. Gravely, F. H. A revision of the oriental sub-families of Tarantulidae (Order Pedipalpi). *Rec. Ind. Mus.* XI, pp. 433-455, pl. xxxi.

1900. Pocock, R. I. Fauna of British India, "Arachnida."

FURTHER NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

VI.—On a New Dromiid and a Rare Oxystomous Crab from the Sandheads, off the Mouth of the Hooghly River.

By B. Chopra, *D.Sc., Zoological Survey of India, Calcutta.*

(Plate VIII.)

Since the publication of my paper on the Dromiacea and Oxystomata of the Sandheads[1] four additional specimens referable to these two orders have been found mixed with some other crabs. Two of these specimens belong to species[2] that are already known to occur commonly in this area, and, therefore, deserve no special mention; the other two are remarkable, one as a representative of a new genus, and the other on account of the rarity of the species to which it has been assigned.

I take this opportunity to acknowledge once again the generous help that the members of the Bengal Pilot Service have been giving unstintingly to the Indian Museum from a very long time past, in the way of bringing valuable material from the mouth of the Hooghly River —an area that has long been known to be of an exceptional zoological interest.

Tribe DROMIACEA.

Family Dromiidae.

Genus **Conchoedromia**, nov.

The new genus may be briefly defined as under :—

Carapace elongate, longer than broad, hardly tomentose, well areolated, with regions distinct and grooves well impressed.

Front cut into three teeth; middle one on lower plane than the side ones. Antennal flagella shorter than carapace.

Palate somewhat demarcated from epistome. External maxillipeds operculiform, but having a somewhat pediform cast on account of the coarseness of flagellum and the comparatively slight expansion of merus; maxillipeds not completely closing buccal cavern.

Chelipeds subequal, stouter than legs.

Last two pairs of walking legs subdorsal in position; third pair shorter than preceding ones, but stouter, with huge talon-like dactyli. Fourth legs very greatly reduced, with their minute dactyli ending in long setae.

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[1] Chopra, *Rec. Ind. Mus.* XXXV, pp. 25-52 (1933).

[2] These two specimens have been identified as *Conchoecetes artificiosus* (Fabr.), and *Dorippe fachkino* (Herbst). Both these species are fairly common at the Sandheads, *vide* Chopra, *op. cit.*, pp. 28 and 50, 51.

Abdomen consisting of seven free segments, without any distinct platelets between the last two segments; terminal segment in male rather long.

Genotype.—*Conchoedromia alcocki*, sp. nov.

Although I have included *Conchoedromia* in the family Dromiidae, the genus possesses a number of characters that are not usually met with in this family. The elongate carapace with well-marked grooves, the superficially pediform maxillipeds and the absence of small plates between the last two abdominal somites are some of the characters that are peculiar to the Homolodromidae, but that the present genus cannot be included in this family is indicated by the fact that, among other characters, the antennal flagella are short, the first two legs are very much shorter, the third are longer and the fourth are far more reduced than is usually the case in the Homolodromidae. Within the Dromiidae, *Conchoedromia* appear to combine the characters of *Cryptodromia* and *Conchoecetes*, in addition to having some characters peculiar to itself. The general shape is that of a *Cryptodromia*; the areolated carapace, practically without any tomentum but with the grooves deeply impressed, and the chelipeds and some of the, more or less nodular, legs show a superficial resemblance to *C. ebalioides*[1] Alcock and *C. gilesii* Alcock[1]. The third pair of legs, on the other hand, though shorter than the two preceding pairs, are as stout, and end in huge talon-like dactyli; these are very similar to those seen in members of the genus *Conchoecetes*. The fourth legs show a greater reduction than is usually met with in either of these two genera. Further, the shape of the external maxillipeds and the absence of plates between the last two abdominal somites are also characters that are not present either in *Cryptodromia* or in *Conchoecetes*.

Conchoedromia alcocki, sp. nov.

(Plate VIII, figs. 1-6.)

The carapace is hardly tomentose, and there are only a few hairs on the borders of some of the leg joints.

The carapace (Plate VIII, fig. 1) is elongate, roughly pentagonal in shape, with the front rather prominently projecting and the posterior border slightly curved. It is longer than broad, the greatest breadth being about five-sixths of the length. The surface is closely covered with minute granules, and is conspicuously areolated. The individual areolae are well separated from one another. The cervical and the "branchial" grooves are distinct.

The front is moderately prominent, is grooved along the median line, and is cut into three pointed teeth, of which the middle one is on a lower level than the others. In one specimen the middle tooth is larger than, and projects beyond, the lateral teeth, while in the second example it is distinctly smaller.

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[1] Alcock, *Cat. Ind. Decapod Crust.*, Part 1, pp. 53-55, pl. iii, figs. 12, 13 (1901).

The upper orbital border is very oblique and is minutely serrulate. The inner supra-orbital tooth of the higher Brachyura is represented by a small dentiform process. The outer orbital angle is not pronounced.

The lateral borders of the carapace are serrulate and are very prominently cut in about the middle. The antero-lateral borders are practically straight and are without any teeth, but a row of minute teeth belonging to the outer border of the sub-hepatic region is visible beyond the antero-lateral border. At its posterior end the antero-lateral border bulges out in a somewhat acute prominence, and the incision of the lateral border of the carapace, referred to above, is formed by the postero-lateral border meeting this bulge well on the inside. The postero-lateral borders are regularly convex and are more strongly serrulate than the antero-lateral. The posterior border is slightly curved.

The lower wall of the common orbito-antennular fossa (Plate VIII, figs. 2 and 3) is, as usual, formed by the basal antennular joint, the basal antennal joint and the sub-orbital lobe. The sub-orbital lobe is rather small and has its free margin beset with minute teeth. The two freely movable basal joints of the antenna have the usual shape, and the second joint is produced at its antero-external angle. The flagellum is considerably shorter than the carapace. The eyes have short thick stalks and the corneae are dark pigmented.

The third pair of maxillipeds (Plate VIII, figs. 3 and 4) do not completely cover the buccal cavern, and on account of the moderate expansion of the ischium and merus, and the coarseness of the flagellum have a superficially pediform appearance. The inner borders of the ischium and merus are serrulate and hairy, while there are patches of minute tubercles on their exposed surface.

The chelipeds (Plate VIII, fig. 5) are more massive than the walking legs and are subequal. They are a little longer than the carapace. The outer and upper surface of all the joints is sparsely covered with minute tubercles. All the borders of the arm are cristiform and sharply denticulate, and the upper border is somewhat raised. The wrist is nodular, and its borders and those of the palm are minutely serrate and sharply cristiform. The teeth near the distal end of the inner border of the wrist are more prominent than the others, and there is a slanting row of minute, rounded tubercles on its upper surface. The palm is swollen and has some indistinct rows of tubercles on its upper and outer surface. The margins are sharply cristiform and minutely dentate, and there is a prominent nodule near the junction of the movable finger. The latter is strongly arched, and its upper border is dentate and somewhat hairy. The dactylus is distinctly longer than the upper border of the palm, and its pointed tip fits into a notch in the tip of the fixed finger. The latter is short and stumpy and both the fingers are armed with teeth along their inner margins.

The first two pairs of walking legs are long, the first being only a little longer than the chelipeds. The margins of the different segments are somewhat serrate. There is a small nodule on the carpus near its distal end, and a small rounded tubercle at the junction of the propodus

and dactylus. The dactylus is long, lanceolate and somewhat curved, and is serrate along the anterior and hairy along both the margins. The borders of the other segments are also sparsely hairy. The merus is not appreciably expanded along its upper border. The third legs are shorter than those of the two preceding pairs, but are markedly stouter. Their segments are short and stumpy, almost nodose, and the large talon-like dactylus works against a prominent cupped and toothed projection near the proximal end of the posterior border of the propodus. The dactylus is strongly curved and its inner border is somewhat serrate and hairy. The fourth legs (Plate VIII, fig. 6) are very greatly reduced, and like those of the third pair are subdorsal in position. Their minute dactyli end in five or six long setae. The borders of the other segments are minutely serrate and are beset with long hairs.

The abdomen in the male consists of seven distinct segments, the last of which is rather long and has its free terminal margin profusely hairy. There are no distinct platelets between the last two segments. The first segment is, as usual, produced laterally, and the first five segments show a distinct convexity along the middle line.

The spirit specimens are pale-whitish in colour and have no distinctive markings.

The larger of the two specimens, which is figured on plate VIII, figs. 1 and 2, has a carapace length of 6·2 mm., while the greatest breadth is 5·2 mm. The other example is 5·6 mm. long and 4·7 mm. broad. They are both males.

Type-specimen.—C 1689/1, Zoological Survey of India (*Ind. Mus.*).

Locality.—The two male specimens on which the foregoing description is based were collected by officers of the Bengal Pilot Service on board the Pilot vessel "Lady Fraser" at Sandheads, off the mouth of the Hooghly River in February, March 1928. The depth of water in this area is about 20 fathoms, and the bottom for the most part consists of soft ooze-like mud, with patches of sand and shells here and there. The specimens are without any protecting shells on their backs.

Tribe OXYSTOMATA.

Family LEUCOSIIDAE.

Genus **Actaeomorpha** Miers.

Actaeomorpha morum Alcock.

1896. *Actaeomorpha morum*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 172, 173, pl. viii, fig. 3 and *Illust. Zool.* "*Investigator*", pl. xxvii, fig. 4.

A single female example of this apparently rare species has been collected at the Sandheads. It has a carapace length of a little over 10 mm., and is about 12·5 mm. broad. It is possibly immature.

The Sandheads specimen agrees in every particular with Alcock's description and figures of this species, as also with the two examples on which he based the description. The species is very easily recognised by its strongly convex carapace, studded with pearl-shaped vesiculous

granules, having a broad, sculptured marginal ring from which the different regions of the carapace are completely isolated. The regions are further isolated from one another by broad channels. The chelipeds, legs and other parts of the body agree exactly with Alcock's excellent description of the species.

Actaeomorpha morum was hitherto known only from two female specimens obtained by the R. I. M. S. S. " Investigator " off the Ganjam coast, in the Bay of Bengal at a depth of 28-30 fathoms. The present record from off the mouth of the Hooghly River does not materially extend the range of the species. The depth of water at this place is above 20 fathoms, and it is likely that the bottom at the exact spot from which the specimen was taken consists of sand, perhaps mixed with shells. All the other species of the genus are also known to live on beds of corals, shingle or sand and shells.

The species of the genus *Actaeomorpha* are for the most part restricted to the Indo-Pacific area, though one species extends to the Kermadec Island in the South Pacific. On the west the genus goes up to the east coast of Africa[1]. Ihle[2] has enumerated the species so far known and has given notes on their distribution. All the species are more or less rare.

The Sandheads specimen is registered in the books of the Zoological Survey as under :—

C 1691/1	Sandheads, mouth of the River Hooghly.	" Lady Fraser " Nov. 1923	1 ♀

The colour of the present specimen, in spite of its long immersion in spirit, is still light orange on the dorsal surface with the ventral surface whitish. There are two barnacles attached to the dorsal surface of the carapace.

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[1] Stebbing, *Ann. Durban Mus.* II, pp. 272, 273 (1920).
[2] Ihle, *Siboga Exped. Rep.* XXXIX b[2], pp. 308, 309 (1918).

EXPLANATION OF PLATE VIII.

Conchoedromia alcocki, gen. *et* sp. nov.

FIG. 1.—Dorsal view of the type-specimen : $\times 5$.

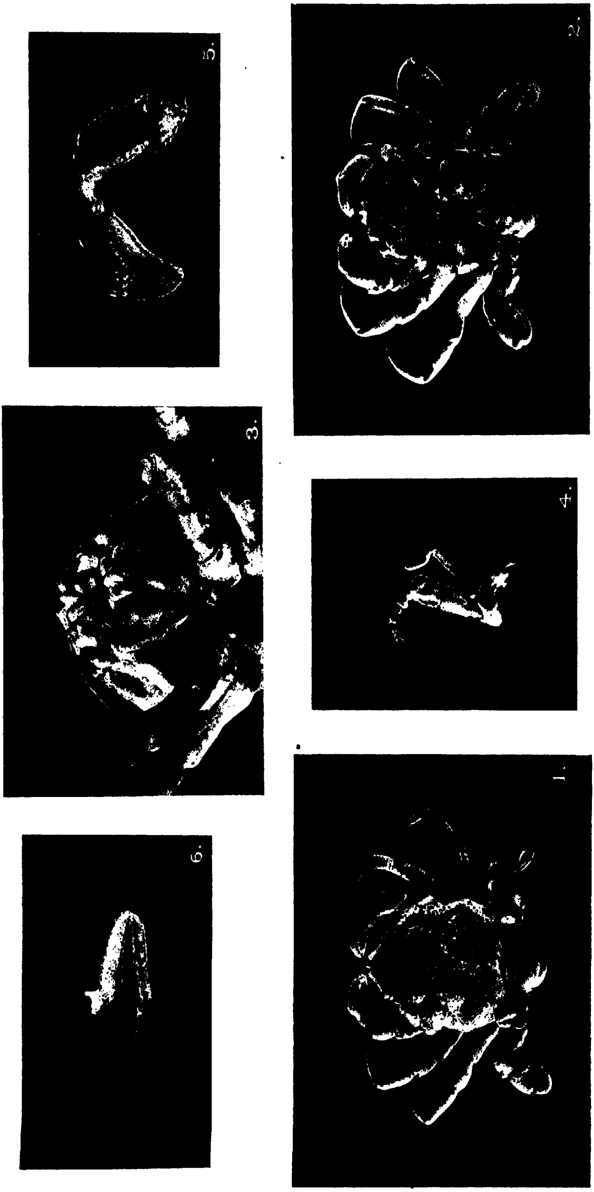
FIG. 2.—Ventral view of same : $\times 5$.

FIG. 3.—Ventral view of anterior part, further enlarged : $\times 8$. Antennal flagellum of one side is missing.

FIG. 4.—Ventral view of third left maxilliped : $\times 10$.

FIG. 5.—Left cheliped, further enlarged : $\times 10$.

FIG. 6.—Fourth right leg, further enlarged : $\times 12$.



Conchoedromia alcocki, gen. et sp. nov.

THE SYSTEMATIC POSITION OF HAMILTON'S SPECIES OF GOBIOID FISHES FROM THE GANGES.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

As is fully realised by all ichthyologists interested in the Indian fauna, the specific validity of a number of species described by Hamilton (once Buchanan) in his "Gangetic Fishes"[1] is not finally established. Hamilton published his monumental work in the absence of a great many of his drawings and several volumes of his manuscript notes, and, in consequence, the published descriptions of several species are defective while it has been a matter of considerable difficulty to identify the species that are not figured. This defect has been removed partially by the publication of Hamilton's manuscript drawings[2], but considerable work yet remains to be done for defining precisely the specific limits of several species. The difficulty is augmented by the fact that Hamilton, as pointed out by me in 1929, preserved no specimens, and in the absence of such material, his drawings are the only indications we possess of the different species described in the "Gangetic Fishes". To straighten this tangle, the only course open is to secure topotypes (specimens from type-locality), but here again it has to be taken into consideration that in places the configuration of the country has changed considerably since Hamilton's time: this was indicated[3] in the case of the type-locality of *Amblyceps mangois* (Ham. Buch.). It is fortunate, however, that Hamilton left comprehensive notes regarding the localities, local names and the dates of his original descriptions in a volume of "Original Notes concerning the Gangetic Fishes" which is now preserved in the Library of the India Office in London.

While working on the brackish water fauna of the Gangetic Delta, the Gobioid fishes attracted my special attention on account of the great structural and biological adaptations exhibited by them. During several visits to Uttarbhag, a trading village on the *Piali Nadi* in the 24-Parganas, a large collection of Gobioid fishes was made, and, when sorting out the material, it was observed that almost all the forms described by Hamilton from the estuaries of the Ganges were represented in it. As the material came from the type-locality (*vide infra*) and as in recent years two species of Hamilton had been redescribed under new names, it seemed to me desirable to publish my observations on the systematic position of Hamilton's species of Gobioid fishes from the Ganges.

Sewell[4], in his recent study of the fauna of the Salt Lakes, Calcutta, has pointed out that "for several years past there has been a steady

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[1] Hamilton, *An Account of the Fishes found in the River Ganges and its branches* (Edinburgh: 1822).

[2] For location of published drawings see Hora, *Mem. Ind. Mus.* IX, pp. 182-191 (1929).

[3] Hora, *Rec. Ind. Mus.* XXXV, p. 612 (1933).

[4] Sewell, *Rec. Ind. Mus.* XXXVI, p. 46 (1934).

change in the conditions existing in and the general character of some of the rivers in Lower Bengal, and these changes have had a profound effect on the Salt Lakes and the associated streams and thus indirectly on the general character of the fauna of certain areas." There is no doubt that since Hamilton's time considerable changes have occurred in the geography of the Gangetic Delta, especially of the area in the neighbourhood of Calcutta. It is known that though Hamilton entered the service of the Honourable East India Company as an Assistant Surgeon on the Bengal Establishment on 26th September, 1794, he actually took up residence in Bengal in the later half of 1796, when, on his return from Burma, he was posted to Luckipoor (Lakhipur or Lakshmipur), 23 miles from the headquarters of the present district of Noakhali in South-Eastern Bengal and in the time of the East India Company a flourishing centre of the weaving industry. He lived at Puttahaut, not far from the Padma River (The Meghna) and about six miles north of Luckipoor, from the later half of 1796 to a considerable part of 1798. Buchanan began to take interest in fishes at Puttahaut and had actually made a few observations, when he was transferred in the beginning of October 1798 to Baruipur in the 24-Parganas about 18 miles from Calcutta. Till the commencement of 1800, Buchanan, while stationed at Baruipur, drew up the descriptions and had drawings made of the fishes of the area, mostly estuarine. The result of his studies up to the beginning of 1800 are embodied in the manuscript entitled "Piscium Bengalae inferioris Delineationes septuaginta octo",[1] which is now preserved in the library of the Asiatic Society of Bengal. Buchanan's investigation of brackish water fishes was interrupted from the beginning of 1800 to the middle of 1814, but in 1814, when he was posted as Superintendent of the Royal Botanical Garden, he resumed his interest and described several estuarine fishes from the Hooghly River and connected pools below Calcutta and from the Calcutta Salt Water Lakes. With the possible exception of one species of Gobioid fishes, the remaining were obtained by Buchanan during his residence at Puttahaut, Baruipur or Calcutta. The table on the opposite page shows the provenance and dates of the original descriptions, the local names, up-to-date scientific names, etc., of Gobioid fishes described in his "Gangetic Fishes". The species marked with an asterisk (*) in the table are described in the 1800-manuscript and, therefore, must have been obtained by Buchanan during his stay at Puttahaut and Baruipur.

Of the 16 species enumerated in the table, descriptions of 8 species are to be found in the 1800-manuscript; while five of the species were obtained by Buchanan during his tenure as Superintendent of the Royal Botanical Garden. One species—*Gobius gutum*—was described during his survey of the Rungpur and Purnea districts, but regarding this he remarks in the "Gangetic Fishes" that "this fish I found in the lower parts of the Padda or Padma River, which Major Rennell calls the Great Ganges". Presumably the specimens on which he based his description were sent to him from the lower part of the Padma River.

Since Hamilton's discovery of *Gobius gutum*, it has never been found again and, therefore, regarded as a doubtful species by ichthyologists.

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[1] Hora, *Journ. As. Soc. Bengal* (N. S.), XXVII, pp. 123-135, 1931 (1933).

Scientific Name in "Gangetic Fishes".	Habitat in "Gangetic Fishes".	Local Names in "Original Notes".	Date and place of original description.	Up-to-date Scientific Name.
**Gobioides rubicundus*, p. 37, pl. v, fig. 9.	Estuaries of the Ganges	*Laal Chaangooaa*; *Lal Ghagra*, Calcutta.	?	*Taenioides rubicundus* (H. B.).
Gobioides ruber, p. 38. (Hora 1929, pl. xviii, fig. 2).	Estuary below Calcutta	*Lal Chenggo*	Calcutta, 4th November, 1814.	*Trypauchen vagina* (Bl. & Schn.).
**Gobius bato*, p. 40, pl. xxxvii, fig. 10.	Estuaries of the Ganges	*Bhato*, Luckipore; *Goole* and *Chaungooaa*, Calcutta.	?	*Apocryptes bato* (H. B.).
* *Gobius*, *changua*, p. 41, pl. v, fig. 11.	Estuaries of the Ganges	*Chaungooaa*	?	*Pseudapocryptes lanceolatus* (Bl. & Schn.).
**Gobius viridis*, p. 42, pl. xxxii, fig. 12.	Estuaries of the Ganges	*Chaungooaa*	?	*Scartelaos viridis* (H. B.).
**Gobius plinianus*, p. 45, pl. xxxv, fig. 13.	(Described as the most common species.)	*Dāns* and *Hona Meno*, Calcutta.	?	*Boleopthalmus boddaerti* (Pall.).
Gobius septemradiatus, p. 46	?	*Doag Dans* and *Dawis*	?	*Periophthalmus schlosseri* (Pall.)
**Gobius novemradiatus*, p. 47, pl. ii, fig. 14.	?	*Daans*	?	*Periophthalmus schlosseri* (Pall.).
Gobius tredecemradiatus, p. 48	?	*Doag Dans* and *Dawis*	?	*Periophthalmus schlosseri* (Pall.).
Gobius gutum, p. 50. (Hora 1929, pl. xiv, fig. 7).	Lower parts of the Padda or Padma river.	*Gutum baliya*	Padma river, 4th September, 1809.	*Glossogobius giuris* (H. B.) (Pug-headed and abnormal form).
**Gobius giuris*, p. 51, pl. xxxiii, fig. 15.	Ponds and fresh water rivers of the Gangetic provinces.	*Pookhoreeaa Baaleeaa*, *Pukhoriya baliya* and *ghiyuri*.	?	*Glossogobius giuris* (H. B.).
Gobius sadanundio, p. 52 (Hora 1929, pl. xviii, fig. 3).	Estuaries near Calcutta	*Sadanundi bele*	Botanical Garden, 13th January 1815.	*Stigmatogobius sadanundio* (H. B.).
Gobius chuno, p. 53. (Hora 1929, pl. xiv, fig. 6).	Estuary below Calcutta	*Chănŏ*	Botanical Garden, 18th January, 1815.	*Gobiopterus chuno* (H. B.) (=*Micrapocrytes fragilis* Hora).
Gobius nunus, p. 54 (Hora 1929, xiv, fig. 5).	River below Calcutta	*Thutkuri bēlē* and *Nūnī bele.*	Botanical Garden, 18th January, 1815.	*Ctenogobius nunus* (H. B.) (=*Gobius alcockii* Annandale).
**Cheilodipterus culius*, p. 55, pl. v, fig. 16.	Ponds and ditches of Bengal	*Nucli*, *Kuli Beliya*	?	*Eleotris fusca* (Bl. & Schn.).
Cheilodipterus butis, p. 57 (Gray 1838, II, pl. xciii, fig. 3).	River below Calcutta	*Bhutī bēlē*	Botanical Garden, 13th January, 1815.	*Butis butis* (H. B.).

In the description of the fish, Hamilton referred to its close similarity with *G. giurus*. A careful study of the figures[1] and descriptions of the two species has shown that the former may be an abnormal form of the latter, which is a very widely distributed species of India and is adapted to live under varying conditions of salinity, etc. According to Hamilton, the principal features in which *G. gutum* differs from *G. giurus* are (*i*) 13 rays in the pectoral fin of *G. gutum* as against 22 rays in that of *G. giurus*, (*ii*) head small and narrower than the body in *G. gutum*, while it is wider than the body in *G. giurus* and (*iii*) the lower jaw shorter than the upper in *G. gutum* and *vice versâ* in *G. giurus*. A comparison of the figures also shows that the chief differences lie in the form and structure of the head which, in my opinion, are due to the pug-headed condition of *G. gutum*. The smaller number of rays in the pectoral fin is probably another abnormal feature. It seems likely, therefore, that *G. gutum* was described from an abnormal pug-headed specimen of *G. giurus*.

To verify this surmise a photographic copy of the original drawing of *G. gutum* was sent to the Collector of the Noakhali district with a request that any information and specimens of *Gutum baliya*, if available, may kindly be obtained. In reply the Collector sent seven specimens and remarked that a fish locally known as *Gutum Baliya* " is available in this district in abundance ". All the seven specimens sent by the Collector are *Glossogobius giurus*, and now there seems no doubt that *G. gutum* and *G. giurus* should be regarded as conspecific.

There are two species, *G. septemradiatus* and *G. tredecemradiatus*, about which no definite information exists, but there can be hardly any doubt that Buchanan obtained them while stationed at Calcutta, as the forms are abundant in the estuaries. Moreover, these forms are conspecific with *G. novemradiatus* and all the three names are synonymous with *Periophthamodon schlosseri*, a species very variable in regard to the number of spines in the first dorsal fin (0—15). I have obtained specimens of all the species referred to above from the neighbourhood of Calcutta and especially from Uttarbhag, which is situated about 5 miles to the south-east of Baruipur. In the " Original Notes ", the Luckipore name of only one species is mentioned and in the " Gangetic Fishes ", *G. gutum* is definitely stated to have been collected from the Padma River, so it may be reasonable to presume that at Puttahaut Buchanan became familiar with only two species of Gobioid fishes.

I include here a short summary of the changes in the configuration of the areas near Puttahaut and Baruipur. Rennell's map (1780-1790) shows " the Meghnā flowing past Lakhipur, then an important factory of the East India Company, sweeping in a steady curve round the south-west of the district and passing some five miles south of the present station of Naokhali, and then inclining slightly northward on to the mouth of the Feni where it flowed some two miles south of Companyganj"[2]. Hooker found in 1850 that Meghnā was moving gradually to the west, and the tide rose about 14 feet. With regard to the configuration of the area near Lakshmipur, the Collector of Noakhali informs me that

[1] For a figure of *G. gutum* see Hora, *Mem. Ind. Mus.* IX, pl. xiv, fig. 7 (1929).
[2] Webster, Eastern Bengal and Assam District Gazetteers. Noakhali, p. 7 (1911).

"an area of about 4 or 5 miles to the south of Lakshmipur has, of late, been diluviated and new chars, *viz.*, Char Ramani Mohan and Char Martin, etc., have been formed, thus diverting the course of the Meghnā River near Lakshmipur to flow by the south side of Char Ramani Mohan."

In the old days, Baruipur used to be a big trading centre and was situated on the banks of the Adiganga, a tidal creek. Now the bed of Adiganga is represented by a series of freshwater tanks and there is no brackish water in the immediate neighbourhood of the place, but it is likely that 136 years ago, when Buchanan was living at Baruipur, there were brackish water pools in the bed of the Adiganga near Baruipur. Uttarbhag is now a big fishing centre and lot of fish from this place are sold daily in the Baruipur market and it is likely that Buchanan may have also obtained his specimens from neighbouring places. Under these circumstances, the specimens from Uttarbhag can be regarded without any hesitation as topotypes of the species described by Buchanan during his stay at Baruipur.

In view of the above remarks, the forms listed above are referable to 13 species, all of which are well-known though two of these—*Gobiopterus chuno* and *Ctenogobius nunus*—have become familiar in literature under taxonomically unsound names. The remaining eleven species are known to be widely distributed in the seas and estuaries of India, Burma, Malay Archipelago and of countries further east.

In the following pages, therefore, the systematic position of Hamilton's two little know species is discussed.

Gobiopterus chuno (Ham. Buch.).

1822. *Gobius chuno*, Hamilton, *Gangetic Fishes*, p. 53.
1923. *Micrapocryptes fragilis*, Hora, *Mem. Ind. Mus.* V, p. 751.
1929. *Gobius chuno*, Hora, *Mem. Ind. Mus.* IX, pl. xiv, fig. 6 (Ms. drawing of Hamilton-Buchanan reproduced).
1931. *Gobiopterus fragilis*, Koumans, *Pre. Rev. Genera Gobioid Fish.*, p. 32.

Gobiopterus chuno was described by Hamilton-Buchanan from "the estuary below Calcutta", and a reference to the "Original Notes" shows that the species was discovered by him in January 1815 while stationed at the Royal Botanical Garden. *Chuno* is a name collectively employed for small species of fish and prawns in Calcutta and there is no doubt that in the specific name reference is made to the small size of the fish and to its diaphonous colouration. Judging according to the present day standard, Hamilton's description of the species is inadequate and it is greatly to be regretted that he had not access to the figure of the species when he published its description in the "Gangetic Fishes". In these circumstances, it is not surprising that no notice has been taken of this species by any ichthyologist; even Day omitted to refer to it in his monumental work on the "Fishes of India".

In 1923, I described a small, transparent Goby from the Chilka Lake and the Baliaghata Canal near Calcutta. It was so remarkable that a new genus was proposed for its accommodation, and its close affinity to *Gobius brachypterus* Bleeker was indicated. Unfortunately, I missed to note at the time that Bleeker had already proposed a separate genus

Gobiopterus for his *G. brachypterus*. Kouman has now directed attention to this omission and after an examination of a cotype of my species—*Micrapocryptes fragilis*—has referred it to *Gobiopterus*.

A careful study of the description and figure of Buchanan's *Gobius chuno* shows that, in all the points noted by Buchanan in his short description, it agrees very closely with the transparent Goby described by me, and I have no doubt that the two are conspecific. The most salient feature, however, is the character of the teeth, but, with the appliances available to Buchanan, he was unable to determine their nature and remarked that "The structure of the *teeth* in such a minute animal cannot be readily ascertained, although these organs evidently exist." The principal features in which the two descriptions agree are :—

i. Small size.
ii. Diaphonous colouration with black dots.
iii. Oblique and upturned mouth with the lower jaw longer than the upper.
iv. Forward position of the eyes.
v. Five short rays in the first dorsal fin, and seven to eight rays in the second dorsal.
vi. Occurrence in the estuaries near Calcutta.

Besides these, there are several other minor points of agreement also.

Gobiopterus consists of small pelagic species which correspond in habits with the European transparent Gobies of the genera *Aphia* and *Crystallogobius*. So far as I am aware, *Gobiopterus* is represented by three forms, *G. brachypterus* Bleeker[1] from the Grati Lake in Java. *G. chuno* from the Chilka Lake and the Salt Lakes, Calcutta, and *G. sp.*[2] from the Talé Sap, Siam. It is significant that all the three forms are known from brackish water lakes and in the Chilka Lake *G. chuno* was found in the main area where the specific gravity of the water varied from 1·0020 to 1·0080. The salinity of the other pieces of water in which *Gobiopterus* lives is not known.

The alimentary canal of *G. chuno* is a broad simple tube ; it is somewhat dilated in the region of the stomach and is about one-third the total length of the fish. An examination of the stomach contents has shown that the fish feeds on Copepods and other planktonic crustacea. Thus from its structure, colouration and feeding habits, the fish seems to be a true pelagic species. The structure of the pelvic fins, as a long funnel-like tube, also shows that these fins are not used for adhesion as is the case in a majority of the other Gobioid fishes.

Ctenogobius nunus (Ham. Buch.).

1822. *Gobius nunus*, Hamilton, *Gangetic Fishes*, p. 54.
1876. *Gobius nunus*, Day, *Fish. India*, p. 297.
1906. *Gobius alcockii*, Annandale, *Journ. As. Soc. Bengal* (N. S.), II, p. 201, 1 fig.
1923. *Ctenogobius alcockii*, Hora, *Mem. Ind. Mus.* V, p. 744.
1928. *Ctenogobius alcockii*, Hora, *Rec. Ind. Mus.* XXX, p. 37.
1929. *Gobius nunus*, Hora, *Mem. Ind. Mus.* IX, pl. xiv, fig. 5 (Ms. drawing of Hamilton-Buchanan reproduced).

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[1] Bleeker, *Nat. Tijdschr. Ned. Ind.* IX, p. 401 (1855).
[2] Hora, *Mem. As. Soc. Bengal* VI, p. 493, fig. 7 (1924).

This is the smallest of the Indian Gobies and was described by Hamilton from "the river below Calcutta". In his "Original Notes", the description of this species is dated 18th January 1815, when Buchanan was stationed at the Royal Botanical Garden. Among other characters, Hamilton noted that *C. nunus* "has six irregular black belts, one passing through the eye, a second on the gill-covers, the third at the pectoral fins, the fourth at the vent fin, the fifth behind the second back fin, and the sixth at the end of the tail". It was also noted that "the first back fin contains six undivided rays." The species remained undetermined for a long time and it appears that Cuvier and Valenciennes and Günther considered the original description inadequate for the specific recognition of the species and, therefore, did not include it in their systems of classification. Day, who had access to Buchanan's manuscript drawings in the library of the Asiatic Society of Bengal, redescribed this species from a small specimen "captured by the late Dr. Stoliczka in a freshwater stream, near Moulmein" and thus extended its range from Hooghly to Burma. The description of its colouration agrees very closely with that given by Buchanan, but its dorsal fin formula "D $5/\frac{1}{9}$" is different. Unfortunately, Day did not figure this small species nor directed attention in his description to its manuscript drawing in Buchanan's collection of drawings in the Asiatic Society of Bengal. No one seems to have taken notice of this species after Day.

In 1906, Annandale described a new species *Gobius alcockii* from a large number of specimens obtained at Port Canning in brackish water and at Calcutta in fresh water. Annandale's description of the colour of his species is identical with that given by Hamilton and Day for *G. nunus*, and in other particulars also the two species appear to be conspecific. According to Annandale, the dorsal fin formula is "D 5 $\frac{1}{6-7}$" but in the large number of specimens examined by me I have always found six undivided rays in the first dorsal. Annandale added a note on the breeding habits of the fish and remarked on the large size of the eggs in *G. nunus*.

In 1907, Annandale[1] recorded "*G. alcockii*" from a tank at Rajshahi, 150 miles north of Calcutta. In 1923, it was recorded by me from the Chilka Lake where it is very common all over the lake. It was also pointed out that the first dorsal fin contains 6 spines and not 5 as described by Annandale. In 1928, the range of the species was extended both towards the east and the west by recording it from Rangoon and Puri on the Ganjam Coast. In 1929, when I published the manuscript drawing of Buchanan's *Gobius nunus*, the great similarity between it and Annandale's *G. alcockii* struck me and later researches have confirmed the view then formed. It is abundantly clear to me now that the two species are identical.

Ctenogobius nunus is very common in brackish water ponds and pools in the neighbourhood of Calcutta and it is always found among vegetation where its banded colouration and absolutely transparent caudal fin makes it inconspicuous. So far as I have been able to ascertain, it feeds on planktonic crustacea or animal and vegetable growths on the

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[1] Annandale, *Rec. Ind. Mus.* I, pp. 41-42 (1907).

stems of water plants. Its alimentary canal is a broad simple tube with the stomach portion dilated and slightly bent in its posterior half. The alimentary canal is less than one-third the length of the fish. The specimens collected late in December and early in January were found to be fully ripe. The species does not seem to grow to more than 18 mm. in total length, and is thus one of the smallest living vertebrates.

C. nunus is found among vegetation both in fresh and brackish waters, but usually it does not live far from tidal influence. Its occurrence at Rajshahi and in Calcutta tanks, however, shows that it is fully acclimatised to fresh water existence. In the Chilka Lake the species was obtained from the main area as well as the outer channel and from waters the specific gravity of which varied from 1·0075 to 1·028250.

C. nunus has not been found so far in flowing water.

NOTES ON INDIAN THYSANOPTERA WITH DESCRIPTIONS OF NEW SPECIES.

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(Plate IX.)

This paper is a supplement to the writer's last three papers[1] on Indian Thysanoptera; it includes notes on fifteen species of which five appear to be new to science and three other forms are new to the Indian region. The material includes collections made by the writer and his fellow workers at Coimbatore, Mr. T. B. Fletcher, till lately Imperial Entomologist, Pusa, Mr. C. C. Ghosh, the Burma Entomologist, Professor D. S. Chowdhry of Cawnpore and Professor Jhaveri of the Poona Agricultural College. The writer's thanks are hereby tendered to all these gentlemen for the help received. He is also thankful to Dr. Priesner for examining his specimens and offering suggestions and criticisms.

The following is a list of the species:—

1. *Hemianaphothrips palmae*, sp. nov.
2. *Pseudodendrothrips ornatissimus* Schm.
3. *Parthenothrips dracaenae* H.
4. *Heliothrips indicus* Bag.
5. *Thrips florum* Schm.
6. *Taeniothrips chaetogastra*, sp. nov.
7. *Panchaetothrips indicus* Bag.
8. *Ecacanthothrips fletcheri*, sp. nov.
9. *Liothrips dampfyi* Ky.
10. *Haplothrips inquilinus* Pr.
11. *Trybomiella ramakrishnae* Ky.
12. *Karnyothrips nigriflavus*, sp. nov.
13. *Androthrips coimbatorensis*, sp. nov.
14. *Mallothrips indica* Ramkr.
15. *Cercothrips* (*Gigantothrips*) *tibialis* Bag.

TEREBRANTIA.

1. **Hemianaphothrips palmae**, sp. nov.

Macropterous female.—Length 1·30 to 1·43 mm. Head yellowish brown, thorax brown with margins of pterothorax rather dark, prothorax light yellowish and the abdomen dark brown. Ocelli large and clear, with red pigment. Legs uniform pale yellow. Feelers pale yellow with the second joint lightly fuscuous and with a distinct brown patch on the distal portion of sixth joint; the following distal joints are also dark. Wings distinctly transparent at basal area, light greyish fuscuous

[1] *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 1029-1040 (1931); *Rec. Ind. Mus.* XXXIV, pp. 277-279 (1932); *Indian Forest Records, Ent. Ser.*, XX (4), pp. 1-12 (1934).

beyond. Eyes large and bulging out. Head broader than long and shorter than prothorax, with no spines or bristles. Cheek distinctly arched and finely serrate but with no bristles; the front margin of vertex very broadly triangular. The vertex is finely transversely striated. Antennal joints: 1st cup-shaped and 2nd elongate oval, longer than first with a seta on it, 3rd and 4th subequal, narrow at base, 5th slightly shorter, all the three broader towards apex, 6th almost as long as 3rd, but broader than the latter, 7th and 8th very short, almost equal and of the same breadh throughout, 9th narrower and slightly longer than 7th or 8th. The partition between 6th and 7th not very clear in some specimens and it is possible that it is only a groove dividing the 6th into two parts. Mouth cone short and bluntly pointed extending just into the middle of prosternum. Prothorax large, as long as head, broader than long, the front margin straight, the sides sharply arched and the base at the junction of the pterothorax conspicuously rounded; it is unarmed. Legs comparatively short, stout and unarmed. Abdomen elongate, much longer than head and thorax together, bluntly pointed at apex. Basal segments with fine transverse striations, 7th and 8th with a sharp lateral spine on each posterior angle, 9th with a transverse row of six long and sharp bristles, the last segment with a similar row of four shorter bristles. Wings extending to 6th abdominal segment. Fore-wing with minute setae along both the veins and a conspicuous curved bristle at costal apex; first vein with five or six setae beyond the basal transparent portion and two distal ones, 2nd with a dozen setae. Fringes long and well developed.

Macropterous male.—1·100 mm. long. Body elongated and more slender than female. General colour similar but with the dark colour of abdomen and margins of thorax deeper in some specimens. Wings extend to tip of abdomen. Apex of abdomen with a pair of conspicuous curved bristles, one on each side. The penultimate segment with two long bristles on each side and a group of short spines at the central region. The four middle segments show a transparent naked transverse patch at the middle, characteristic of some male thrips.

Measurements of type female.—Head: length 0·132 mm., breadth 0·154 mm.; prothorax: length 0·132 mm., breadth 0·220 mm.; pterothorax: length 0·308 mm., breadth 0·297 mm.; abdomen: length 0·792 mm., broadest across 5th and 6th segments. Total length 1·364 mm.

Measurements of antenna.—1st joint 15μ, 2nd 40μ, 3rd 70μ, 4th 55μ, 5th 55μ, 6th 65μ, 7th 10μ, 8th 10μ, 9th 20μ.

Habitat and Locality.—Collected by the author on the flower heads of Date palm (*Phoenix dactylifera*); found in company with *Adiheterothrips jambudvipae*, Ram. on the banks of the Tungabhadra river at Tungabhadra and Siruguppa in the Bellary district.

Described from about ten females and three or four males.

This is the first Indian record of this genus erected by Priesner in 1925 as a subgenus of *Anaphothrips*, Uzel. The most important structural feature of the genus is its three jointed antennal style (antenna 9-jointed). This feature and the characteristic coloration mark it out as a distinct species.

2. **Pseudodendrothrips ornatissimus** Schmutz.

1913. *Pseudodendrothrips ornatissimus*, Schmutz, *Sitz. Akad. Wiss. Wien.* CXXII, p. 998.

Habitat and Locality.—Found as a pest on the shoots of mulberry (*Morus*), Mandalay, Burma (C. C. Ghosh Coll. T. V. R. No. 266). The insect in this material, though appearing at first glance like a *Sericothrips*, agrees in most respects with Schmutz's type described in 1913 from material collected from Ceylon on *Macrocarpus integrifolia*. The structure of the antennae in the present material is similar to the Ceylonese form with the peculiar division of the distal joints; the transverse groove in joint six is clearer than the partition between joints six and seven, and Schmutz appears evidently to have mistaken the boundaries of the joints. The insect is a small (about 1·000 mm. in length) golden yellow species with bright red ocelli, whip-like antennae, short and unarmed head and fairly long greyish wings.

3. **Parthenothrips dracaenae** Heeger.

1854. *Parthenothrips dracaenae*, Heeger, *Sitz. Akad. Wiss. Wien.* XIV, p. 365.
1902. *Parthenothrips dracaenae*, Hinds., *Proc. U. S. Nat. Mus.* XXVI, p. 176.

Habitat and Locality.—A dozen females (no males) collected by the writer on wild *Solanum* and *Tecoma jasminoides*, Nilgiris, 7,500 ft. (T. V. R. Nos. 290 and 316); this is the first record of this well known species in Asia. Differs from Schmutz's *P. octarticulata* recorded from Ceylon in the structure of the antennae and the colour of the fore-wings. This insect appears to enjoy a very wide distribution since it has been noted previously in different parts of Europe, North America and Australia. Dr. Priesner thinks that my specimens are somewhat paler than the European form. There is a detailed description of this insect in Hinds' paper referred to above.

4. **Heliothrips indicus** Bagnall.

1913. *Heliothrips indicus*, Bagnall, *Ann. Mag. Nat. Hist.* (8), XII, p. 291.
1928. *Heliothrips indicus*, Ramakrishna, *Ent. Mem. Dept. Agri. India* X, p. 254.

Habitat and Locality.—On ganja (*Cannabis sativa*), Coimbatore, (T. V. R. Coll.); on Sannhemp flowers, Pusa (P. V. Isaac Coll.). On Date flowers, Siruguppa, Bellary (T. V. R. Coll.). This is a common Indian black thrips found occasionally as a pest on groundnut and other field crops.

5. **Thrips florum** Schmutz.

1913. *Thrips florum*, Schmutz, *Sitz. Akad. Wiss. Wien.* CXXII, p. 1003.
1928. *Thrips florum*, Ramakrishna, *Ent. Mem. Dept. Agri. India*, X, p. 261.
1932. *Thrips florum*, Ramakrishna, *Rec. Ind. Mus.* XXXIV, p. 277.

Habitat and Locality.—On Rose flowers, Poona, (T. N. Jhaveri Coll.). This is one of the commonest of the Indian species of thrips (a reddish brown form) and is found on a variety of plants in S. India. Found often in company with different species of *Haplothrips*.

6. Taeniothrips chaetogastra, sp. nov.

Macropterous female. About 1·400 mm. long. General colour yellowish to yellowish brown. Head and thorax yellowish brown, abdomen and legs of a pale whitish yellow, legs with a slightly darker hue than abdomen. Fore-wings uniform grey, setae dark, fringes grey and hind wings of a lighter shade with the central longitudinal vein grey. Eyes black, ocelli with pinkish pigment. Antennal joints excepting the first which is pale whitish, are of a uniform dark grey colour. The prothoracic and abdominal bristles dark. Head broader than long, fore margin arched, surface of head near junction of prothorax with irregular transverse striae. A pair of conspicuous dark bristles in front of the posterior ocelli, genae slightly arched with two or three very short transparent setae along each. Antenna, first joint stout and cup-shaped with short seta towards apex, 2nd joint narrow at base and gradually widening towards apex with three or four sharp setae, 3rd joint narrow and more or less constricted at the base, widest at centre and then narrowing towards apex with two or three bristles and a forked trichome towards apex, the color is deeper at centre and lighter towards each apex, 4th joint similar in all respects to 3rd though slightly shorter and the bristles are conspicuous in both ; 5th joint narrow at base and widening towards apex, having a distinctly lighter colour at apex, 6th joint almost as long as 4th, elongate oval, broader at base and narrowing towards 7th joint but broadly connected with it, the extreme apex has a lighter hue, 7th very small, 8th an elongated cone longer than 7th and with two or three transparent setae at apex. Mouth cone broadly pointed and reaching middle of prosternum. Prothorax, somewhat broader than long, sides arched ; a pair of dark conspicuous bristles found at each posterior angle. In addition, the hinder margin has a row of four spines situated between the pair at each angle and of these the two in the middle are conspicuous and almost as long as the ones at each angle, the one at each side is smaller. The surface of the prothorax is also fringed with several small setae. Pterothorax almost as broad as long, very slightly arched at the sides ; on the median region there is a group of spines and of these, the middle two are conspicuous. The two hinder pairs of legs are slightly longer than the front pair and all the legs are profusely fringed with short bristles, especially the tibiae. The wings are well developed and reach the 8th abdominal segment, the setae along the veins and the costal margin are dark brown. The upper vein has a basal series of 7 or 8, then there is a long blank and then there are two towards the apex ; the lower vein has a regular series of 13 or 14 in an uninterrupted line ; the second of this series is opposite to the last of the basal series of the upper vein ; the costal margin has about 24 to 26 bristles, one long curved one at apex ; fringes rather scanty and found chiefly along hind border. The hind wing shows a distinct narrow grey longitudinal median vein. Abdomen elongate, very slightly longer than head and thorax together, broadest at base and gradually narrowing towards tail end ; the anal end is not sharply pointed. Each of the abdominal segments has a transverse row of 8-10 short setae on its ventral side. The dorso-lateral margins of the segments are finely transversely rugulose. Posterior margin of 9th segment with a transverse

row of six conspicuous long dark bristles, one pair towards each side and one on the median dorsal region; the last segment has a transverse row of four long pre-apical bristles of the same type; there are also two long bristles, one on each side of the median line anterior to the transverse row of bristles.

Measurements of type.—Head: length 0·121 mm., breadth 0·154 mm.; prothorax: length 0·165 mm., breadth 0·198 mm.; pterothorax: length 0·286 mm., breadth 0·275 mm.; abdomen 0·704 mm. Total length 1·342 mm.

Measurements of antenna.—1st joint 35µ, 2nd 45µ, 3rd 65µ, 4th 60µ, 5th 43µ, 6th 58µ, 7th 10µ, 8th 20µ.

Described from a unique female specimen collected by the author on flowers of Persian Nim, Coimbatore, in company with *Dolichothrips indicus*, Hood-Pr. T. V. R. No. 29 x, September 1923.

The insect is well provided with bristles and setae all over the body, near the ocelli, on the prothorax, and especially on the abdominal segments; and it is, therefore, named *T. chaetogastra*. It does not appear to be any of the species described till now.

7. Panchaetothrips indicus Bagnall.

1912. *Panchaetothrips indicus*, Bagnall, *Rec. Ind. Mus.* VII, p. 257.
1928. *Panchaetothrips indicus*, Ramakrishna, *Ent. Mem. Dept. Agri. India* X, p. 273.

Habitat and Locality.—One solitary female from cotton flower collected by the writer's brother T. V. Subramania Ayyar, Mysore Entomologist, from Bobbur, Mysore, (T. V. R. No. 370). The well known hosts of this insect noted so far have been Turmeric and Arrow-root plants in S. India and Banana in N. India. It was also found once on *Haemelia patens* in Coimbatore. This genus with its only known species is unique and confined to India as far as we know.

TUBULIFERA.

8. Ecacanthothrips fletcheri, sp. nov.

Macropterous female.—Length 2·75 mm. General colour dark greyish brown. Fore tarsi, fore tibiae, the tip of the fore femoral spine yellowish, the middle and hinder tibiae at base and apex and their tarsi yellowish tinged with grey brown. Antennal joints 1 and 2 of same colour as head; third along the outer margin and the basal portion of 4th, 5th and 6th yellowish, 7th and 8th dark grey. Head longer than broad and longer than prothorax; cheeks sub-parallel with three strong tubercles each giving rise to a short sharp bristle along each cheek; the postocular bristle on each side very long projecting forwards beyond the eye. Third antennal joint with double row of sense cones. Ocelli with reddish pigment. Eyes large, oval, placed almost near the anterior margin of vertex. Prothorax rhomboidal with one forwardly directed transparent bristle at each anterior angle and one at each posterior angle. Front legs strongly developed; femur stout with a strong straight tooth at middle of inner margin, tibia narrow at base and curved along inner margin, the latter with three short but conspicuous tubercular

projections towards the apex; tarsus with one strong tooth at base. There are a few short and strong bristles at the basal region of outer margin of femur and coxa. Hind legs normal with a few small bristles on outer margin of femora. Pterothorax stout, longer and broader than prothorax. Wings extending to 7th abdominal segment; fore-wing with the basal spines long, transparent and knobbed, its apex with 22 duplicate hairs. Abdomen elongate, oval, longer than head and thorax together, the segments with spines at posterior lateral angles. Tube rather stout and shorter than head or prothorax with very short and feeble bristles at tip.

Measurements of type.—Head length 0·374 mm.; prothorax length 0·264 mm.; tube length 0·242 mm.; pterothorax length 0·440 mm.; abdomen length 1·650 mm. Total length 2·75 mm.

Measurements of antenna.—1st joint 1·75μ, 2nd 2·75μ, 3rd 3·145μ, 4th 4·170μ, 5th 5·160μ, 6th 6·125μ, 7th 7·85μ, 8th 8·65μ.

In Priesner's recent synopsis of the species of this genus the insect comes near *Bryanti obscurata*, from Borneo, but differs from it chiefly in the colouring and length of antennal joints.

Described from one specimen caught at light in Pusa (T. B. Fletcher Coll.—T. V. R. No. 267).

9. **Liothrips dampfyi** Karny.

1914. *Liothrips dampfyi*, Karny, *Verh. Zool. Bot. Ges. Wien.* LXIV, p. 58.

Habitat and Locality.—On *Tamarix gallica*, Cawnpore, (D. S. Chowdhry Coll.—T. V. R. No. 264). This insect was first described by Karny from the same host plant in Egypt and is a new record for India. In general form the insect appears more like a *Gynaikothrips* than a *Liothrips* and Dr. Priesner who examined the specimens is also of that opinion.

10. **Haplothrips inquilinus** Priesner.

1921. *Haplothrips inquilinus*, Priesnor, *Treub.* II, p. 4.
1928. *Haplothrips inquilinus*, Ramakrishna, *Mem. Dept. Agri. India* X, p. 292.

Habitat and Locality.—On *Mallotus philippinensis*, Taliparamba, Malabar (T. V. R. Coll.) with a *Liothrips* sp. Originally described from Java, and there are previous records on *Mimusops elengi* and *Eugenia jambolana* in South India.

11. **Trybomiella ramakrishnai** Karny.

1926. *Trybomiella ramakrishnai*, Karny, *Mem. Dept. Agri. India* IX, p. 218.

Habitat and Locality.—In flowers of Lupin and other hill plants, Ketti, Nilgiris, 5,000 ft. (T. V. R. No. 391). Previously collected from Chrysanthemum flowers in Coimbatore, and Sandal in Salem District.

12. **Karnyothrips nigriflavus**, sp. nov.

Macropterous female.—Length 1·75 to 2·0 mm. General colour bright yellow and dark brown. Head, prothorax, the first antennal joint, base and inner margin of 2nd joint and the tube dark brown; ocelli with

some red pigment. The legs and rest of the body bright yellow except the ventral tips of the legs and the 7th and 8th joints which are lightly tinged with dark brown; the abdomen in some specimens shows irregular darkish diffused pigment. Wings light flavous almost transparent. Head longer than broad, fore-margin broadly triangular. Sides subparallel, slightly corrugated but not armed. Postocular bristle small and inconspicuous. Antennal joints 1 and 2 short and cup-shaped, 2nd longer than 1st and constricted at base, 3-5 subequal narrow at base and broadening towards apex, 6th broadest at apex and slightly shorter, 7th elongate and of same breadth throughout and 8th a long cone with an apical bristle. Mouth cone broadly rounded reaching just the middle of the prosternum. Prothorax as long as head but broader, the postero-lateral bristles medium sized and knobbed. Fore femur short and stout. Tarsal tooth curved and small; wings extending to 5th abdominal segment and the fore-wings with 2 to 5 duplicate hairs at apex. Abdomen elongated and much longer than head and thorax together. The wing retaining spines well developed in each of the proximal segments and the posterior pair curved and approximating each other at the median line. The spines at the posterior angles of the segments well developed, especially those on the 9th segment; and the bristles at the tip of tube longer than the tube. Tube short with slender long setae at apex which are longer than it.

Measurements of type female.—Head: length 0·187 mm., breadth 0·132 mm.; prothorax: length 0·154 mm., breadth 0·242 mm.; pterothorax length 0·308 mm.; tube length 0·132 mm. Total length 1·848 mm.

Measurements of antenna.—1st joint 30μ, 2nd 40μ, 3rd 50μ, 4th 55μ, 5th 50μ, 6th 40μ, 7th 45μ, 8th 30μ.

Macropterous male.—Length 1 to 1·25 mm. Shorter than female but similar in color and all other features.

Described from numerous specimens (T. V. R. No. 269a) collected on Bamboo in Coimbatore with *Veerabahuthrips bambusae*, Ramkr., and *Androthrips coimbatorensis* described below. Closely allied to *Karnyothrips melaleucus* Bagnall but differs in the colour of the different parts.

13. **Androthrips coimbatorensis**, sp. nov.

Macropterous female.—Length 1·5 to 1·7 mm. General colour uniform pale to dark greyish brown with parts of head, thorax and legs suffused with very pale yellowish tinge, head, post abdominal segments and tube of a slightly darker tinge. First two joints of antenna of a slightly deeper grey than other joints, the middle ones, 3-5 of a lighter hue than the apical joints 7 and 8. Ocelli with red pigment. Wings with very light grey infumation. The fore femora have the outer margin broadly dark grey with the rest of it pale yellowish, fore tibia also of a lighter pale yellowish colour. Middle and hind legs pale greyish. Head longer than broad, broadest just behind eyes, the front margin slightly drawn forwards into a broad triangular process, ocelli with red pigment, clear and well placed forwards; postocular bristle half as long as eye and projecting over eye, cheeks sub-parallel and not armed; mouth cone

broadly pointed, reaching middle of prosternum. Antenna, 1st joint short and stout, 2nd longer and cup-shaped, 3 to 7 subequal, narrow at base and broadening towards apex, 6 and 7 almost of same breadth throughout, 8th a broad cone. Prothorax shorter than head with medium sized bristles at post lateral angles and a row of 5 or 6 long ones at its base where it joins pterothorax. In the fore legs the femur is very stout and incrassated with a conspicuous conical tubercle at base of inner margin, the tibia with a broad projection at apex of its inner margin and the tarsus with a long curved tooth at base. Wings slightly narrow at middle and extending to 6th abdominal segment. Fore-wing with 5 duplicate hairs at apex. 3 basal spines clear. Abdomen elongate with sides always parallel, not broader than pterothorax. the wing retaining spines, well developed. Tube shorter than head or prothorax, with long cilia at apex. 9th segment with 4 long bristles at post margin, 2 on each side; there are small ones between these two.

Measurement of type.—Length 1·628 mm.

Male.—Length 1·232 mm.; shorter than female; similar in other respects.

Described from a few specimens collected on bamboo in Coimbatore with *Karnyothrips nigriflavus*, n. sp., and *Veerabahuthrips bambusae*, Ramkr.; appears different from the species noted before from India, *viz.*, *A. flavipes*, Schm. and *A. ramachandrai*, Ky., especially in the colour of the fore femora, wing hairs and armature of fore femora.

14. **Mallothrips indica** Ramakrishna.

1928. *Mallothrips indica*, Ramakrishna, *Ent. Mem. Dept. Agri. India* X, p. 308.

Habitat and Locality.—In *Eugenia jambolana* fruits, Cawnpore (D. S. Chowdhry Coll.—T. V. R. No. 263). The species was first described as the type species of a new genus by the writer from material collected in leaf galls of the same plant (*Eugenia*), in Marudamalai hills, Coimbatore, 1,500 ft.

15. **Cercothrips (Gigantothrips) tibialis** Bagnall.

1921. *Gigantothrips tibialis*, Bagnall, *Ann. Mag. Nat. Hist.* (9) VII, p. 364.
1926. *Gigantothrips tibialis*, Karny, *Ent. Mem. Dept. Agri. India* IX, p. 239.
1929. *Gigantothrips tibialis*, Ramakrishna, *Ent. Mem. Dept. Agri. India* X, p. 311.

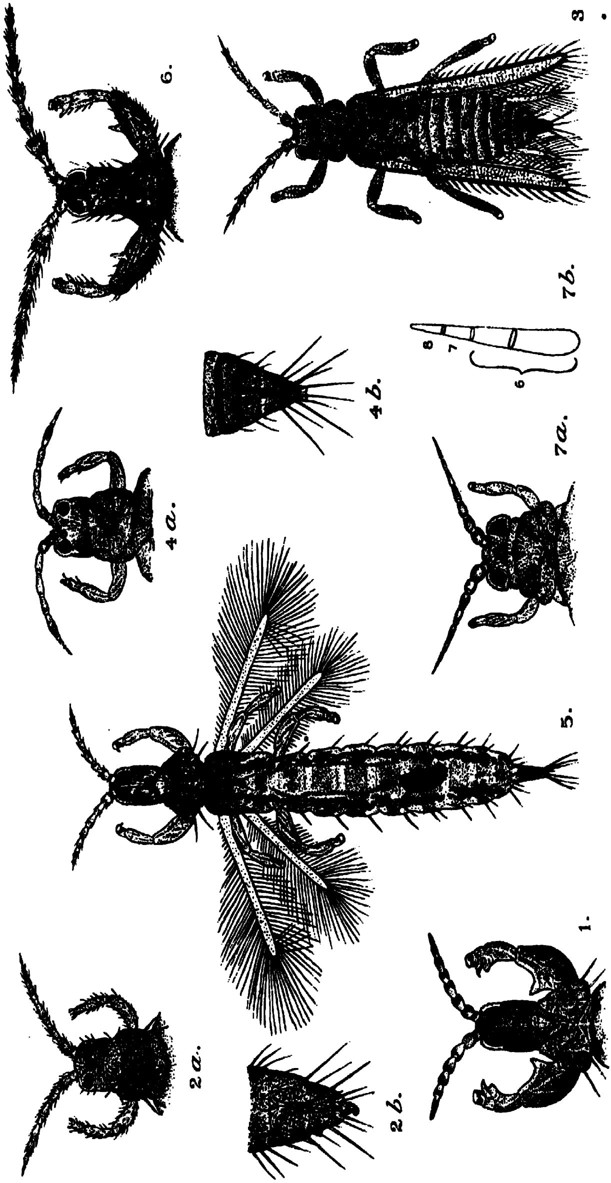
Habitat and Locality.—This giant thrips was recently found in numbers on a wild shrub near the Tungabhadra river Siruguppa (C. S. Balasubramaniam Coll.—T. V. R. No. 388.) The species was originally described from Ceylon by Bagnall and later collected from South India on the same plant (*Careya arborea*) as in Ceylon and noted in the writer's memoir on Indian Thysanoptera. This species, according to the characters given by Hood and in the opinion of Karny and Priesner has to come under Hood's genus *Cercothrips* (p. 73, *Insec. inscit. Washington*, VII, 1919) and is different in generic characters from *Gigantothrips* Z.

MGPIC—III-8-10—11-12-34—440.

EXPLANATION OF PLATE IX.

INDIAN THYSANOPTERA.

1. *Androthrips coimbatorensis*, sp. nov. Fore part of body.
2. *a. Taeniothrips chaetogastra*, sp. nov. Head.
   b. Taeniothrips chaetogastra, sp. nov. Abdomen ♀.
3. *Parthenothrips* dracoenae, H.
4. *a. Hemianaphothrips palmae*, sp. nov. Head.
   b. Hemianaphothrips palmae, sp. nov. Abdomen ♀.
5. *Karnyothrips nigriflavus*, sp. nov. ♀.
6. *Ecacanthothrips fletcheri*, sp. nov.



Indian Thysanoptera.

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